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Within the limits of the northern and elevated region it does not exceed 2.7 millimeters during the course of the year, and averages 5 millimeters for the warm season, that is, it remains within the limits of the norm for the given latitudes. It is somewhat greater at the sea littoral. But within the region of the warm and partly desert steppe, and in non-water discharging areas, the deficiency of precipitation increases considerably reaching the limits of magnitude at Novouzensk and Malyy Uzen', where the annual averages are 4.8 and 4.6 millimeters, while for the warm season they are 7.8 and 7.3 millimeters. The highest monthly figures -- 19.2 and 20.0 millimeters are very close to the figures for Central Asiatic deserts.

Thus, even a cursory survey again supports the above mentioned view, regarding the non-discharging areas of both Uzen' rivers and the Kamysh-Samara lakes (including here parts of the Ural basin, i.e., the area around the Inder Lakes), that this is the dryest area, not only in Nizhneye Povolzh'ye, but throughout the entire southeastern part of European Russia. Drawing of isolines shows quite definitely that the drying influence caused by the proximity of the tremendous complex of waterless, and to a considerable degree non-discharging Asiatic deserts, is reflected strongly in the southern Volga area. The isolines also emphasize earlier conclusions regarding the fading activity of the Caspian Sea in this respect. This influence is very limited, being effective only along the narrow littoral zone. But, in connection with other data frequently noted, it is necessary to modify the initial scheme of climates as drawn by Keppen, which was based only on observations of temperature and rainfall, the last mentioned being very limited, and to establish this as a particularly desert-like region, a region of non-discharging rivers and lakes, with its boundaries somewhat north of the Caspian, but not quite reaching the coast.

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Air Currents

There is a relatively large body of material for the study of air currents collected by the 27 stations in the basin. The results are presented in Table 6 as resultants of wind action based on the repetition from different directions, and as figures giving the number of calm periods, average wind velocity, etc. They are shown only for two characteristic months, January and July. This is sufficient to determine the principal air currents and their sequence.

These figures make it possible to reach the conclusion that winter and summer directions for air currents follow two entirely different schemes within the boundaries of the region under discussion. Around the latitude of Stalingrad, winter currents may be divided into two independent groups of winds. The southern tends, evidently, to gravitate toward the Caspian Sea and then blow on toward the North Caucasus, partly following the Caspian littoral. All stations at the lower reaches of the Volga have at this time winds that, although strong, are inconstant as to direction, as is evident from the insignificant size of the resultants (Tinguta - 8 percent, Akhtuba - 6 percent). This is confirmed by the discrepancy in the indications of the directions of resultants for stations which are close to each other, like Stalingrad (30 degrees for 24 percent calm), Akhtuba (132 degrees for 15 percent calm), Tinguta (277 degrees for 14 percent calm). Together with this there is characteristic a high wind velocity for that month at these stations. These figures all go to show that we have in the littoral zone at the boundary of Yergeni a clearly defined area with frequent calms broken by stormy winds. Southward from latitude 48 degrees (approximately), a system of south, south-southwest, and, southwest wind currents becomes apparent. Along the high bank of the Volga, the regular direction of the currents is disrupted, particularly between Saratov and Syzran' at the elevations of the waterdivides for the Don and Volga systems. The currents, one might say, become forked, bypassing the higher elevations on the right bank of the Volga.

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During the winter such a wind regime for the basin is completely justified by the distribution of atmospheric pressure. A tongue of high pressure, stretching from Asia into the Volga region, becomes a wind divide. On the northern side of the tongue, air masses are obliged to go in a northward direction, while while currents travel in an opposite direction, southward, on the west side of this tongue of high pressure.

In July there is observed an entirely different picture of air currents, particularly, the predominance of west winds in the northern part of the basin which change to northwest winds in the middle and meridional parts. Such a change is responsible for the substitution of a Siberian by an Azov maximum, and, what is more, for the formation of a Persian-Afgan minimum during the summer. Thanks to this, air currents from the west, which come almost latitudinally to the shores of the Volga, having crossed the Volga, bend more and more to the southeast, carrying with them an ever decreasing amount of precipitation. Completely dependent on this entirely general law for the distribution of wind currents during the warm half of the year, there is to be found in the southern part of the territory a successive decrease in the quantity both of precipitation and of humidity of the air, because the air masses travelling over a large expanse of arid land are poor in moisture and cannot give off large quantities of precipitation over the highly warm Caspian littoral.

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Table 6

Name of Station	Number of Years	January: Mean Direction in degrees	January: Calms in Percent	January: Velocity in m/s	July: Mean Direction in degrees	July: Calms in Percent	July: Velocity in m/s
		I	II	III	I	II	III
Kamyshin							
Stalingrad							
Tinguta							
Vol'sk							
Saratov							
Urbakh							
Malyy Uzon'							
Kostychev Experimental Field							
Akhtuba							
Baskunchak							
Oranzhereynyy Promysel							
Biryuch'ya Kosa							
Chetyrekhbugornyy Mayak							
Spasskoye Experimental Field							
Ul'yanovsk							
Syzran'							
Samara							
Kamyshinskiy Khutor							
Yershov							
Pugachev							

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It should be noted that wind velocity in Nizhneye Povolzh'ye is not great, particularly in the summer, and, in connection with this, there is to be found a slight predominance of winds in the indicated direction. They have little stability and frequently give place to a calm. This becomes evident in comparing the results of different series for the same stations, and from the existence of a large number of calms. More than half the stations noted the summer calms to take place in 20, even 40, times out of a hundred. Wind velocity in the non-discharging part of the basin, along the Uzen' rivers and further south, is considerably higher than for the other parts of the territory, which explains the higher rate of evaporation and a corresponding deficiency of saturation.

It is evident, that during the winter when the sea is covered with ice, direction is more fixed than in summer, when there is a constant shift in influence from sea to dry land.

Conclusions

Basically, the scheme of climates, as shown on Map 5, is completely substantiated by the materials considered, with minor modifications and rectifications for the southern part, which, as a region of desert, according to the data on deficiency of saturation, more clearly delineates the particularly hot and dry part. The northern part of the basin should be considered as being cooler and with sufficient moisture to have forests.

A zone of forest-steppe, lying within the limits of the Irgiz basin and adjacent to it in the south, lies on the border of deciduous forest, inasmuch as it receives less moisture. Individual sectors which are better provided with moisture exist dependent on the relief.

Outside the limits of Obshchiy Syrt begins a considerably drier steppe with a summer during which grassy vegetation, within the limits of spring flood waters, is burned out. The area of non-discharging rivers, comprising the basins of the Gor'kaya and the two Uzon's, has a very sultry

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summer and a severe, though short, winter. This is a region of extreme dryness. The tremendous evaporation and heightened deficiency of saturation oblige one to consider the region lying adjacent to the Kamysh-Samara lakes, and somewhat further south of that, as a genuine desert.

The maritime littoral during the winter has certain peculiarities characteristic of a desert, but somewhat mitigated because of the shortness and unstableness of the winter. Due to the influence of the sea, the summer is somewhat cooler than in the neighboring middle part, but at the same time it is more humid.

A contrast (in the climate) of the right and left banks of the Volga is to be noticed almost throughout its entire length, but it is particularly marked in the area stretching from Syzran' to Kamyshin.

With respect to amplitude of temperature, the entire basin should be considered as a region of completely continental climate. The rainfall during the warm season comprises from 60 to 75 percent of the total annual precipitation.

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2. SOILS

Zones and Regions of Geographical Soil Distribution

Three zones of soils are to be found in the Lower Volga Basin: (1) forest-steppe combined with gray forest soils, sandy p e and leached and fertile black earth degradations; (2) steppe black earths, either as black earth and chestnut soils, or finally, as chestnut soils combined with saliferous soils; (3) desert steppe with predominance of salt-complex steppes, in which are found either a combination of light chestnut soils, light brown with salt soils, or combinations of salt flat and salt marsh or finally regions of sands that have been dispersed. It is characteristic that on the right upland side of the Volga the boundaries of the zones differ from those on the left. The zone of the forest-steppes passes along the right side further to the south, at least to Saratov, but on the left its boundary is the Samara River. The steppe zone passes along the right shore down to the southern end of Yergeniy, than as on the left side its boundary appears at the foot of the elevations of the water divides, a little further north than 51 degrees along the line: at the mouth of Yaruslan-Novouzensk-Ural'sk. In this displacement of zones there is shown in part the general deflection of the zones from the latitudinal into the Eastern European plain in the direction of east-northeast, and in part the asymmetrical features of the geomorphological structure of the entire Volga Basin and the terraces of its valley. The zone of desert steppes clearly coincides here with the Caspian depression. To go into the details of the soil combinations of each zone, the Volga left bank terraces are divided in all zones into a special belt, which at first going eastward, changes into a belt of high post-triassic deposits, which also possibly represents a terrace of the Volga considerably older and more grandiose in size, and then goes further to become a belt of ele-

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vations where the soils were formed on the alluvial or deluvial fundamental strata, chiefly, Paleozoic and Neogene. Upon the right side, this last early broadens for the most part upon the shore of the Volga down to Stalingrad. The intersection of these strips with latitudinal zones explains the basic elements of the geography of the soils of the Lower Volga Basin, with the exception of the pre-Caspian lowland, where other elements connected with the history of the Caspian Basin appear.

In the Lower Volga Basin, all the zonal genetic types of soils of colder latitudes are to be found, but mainly those: podzolic, gray forest, black earth, chestnut and light brown together with types of soil of non-zonal diffusions: salt flat, salt marsh, salt melt, bog soils and other kinds of alluvial soils. Below is given the general comparative character of the chief types, applicable to a given territory.

Chief Types of Soils

The boundary of the podzolic zone passes north of the Kama River. In the Lower Volga Basin, as in other localities, this zone is to be found only on separate islands and strips of sandy pine soils. They form, in many places, a very characteristic and large element of forest-steppe landscape (for example, the Volga pine forests along the Mayna, at Bolyy Yar, at Stavropol' and Buzuluk pine forest) although, owing to their insular position they do not seemingly play an essential role in the subterranean nourishment of rivers. Pine sand soils were formed for the most part on ancient alluvial sands, not infrequently on ancient dunes blown from one place to another and having an undulating surface, together with an uneven distribution of soil moisture and vegetation. The dry lichenous pine woods of the elevated and protruding places alternate with the humid mossy pine woods of depressions and change from these into forest bogs.

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SOILS ON THE LEFT BANK OF THE VOLGA

We may begin the description of the soils on the left bank of the Volga with the characteristic Volga terraces from the Kama River to the Samara bend. The Volga valley forms two terraces on young alluvial soils above the floodplain and its meadows: the first terrace over the floodplain (or in an intermediate position) and the second terrace a high one. The intermediate terrace is low (5-6 meters) and impermanent, but it is clearly differentiated. Its surface bears clear traces of its former state (when it was a floodplain), and is usually separated from the upper terrace by rivulets and pools along its edges. Level portions with argillaceous chernozem soils, bearing the indicia of meadow origin, alternate with rolling portions with sandy soils, which are sometimes wooded and sometimes occupied by farm-houses and orchards. The upper terrace is for the most part separated from the intermediate terrace by precipices (30-40 meters high) displaying the ancient strata of Volga alluvial deposits. The outer rim of the terrace above the precipice is not infrequently raised to some extent in the form of an embankment, consisting of drifted sand usually covered by pine groves (such as the pine groves at Beloyarsk and other places). But deeper into the Transvolga the upper terrace usually levels out and extends for dozens of kilometers in the form of a lightly dissected plain of steppe character, covered with chernozems which are usually of sandy loamy or lightly to moderately loamy nature, of relatively greater thickness (down to the level of the humus horizon) than the argillaceous chernozems of the Transvolga syrts. Solonetzes or saline soils are not infrequently encountered in ravines and land-locked depressions.

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The tributaries of the Volga break up the steppe-like plains of the upper terrace into a number of distinct areas, separated by the belts of forest soils and floodplain which parallel the banks of these minor rivers. Thanks to this, between Spassk and the Samara bend isolated areas or "inlands" of chernozems alternate with belts of forest soils, mostly sandy loams. Moreover, the belts of pine woods on sand, which are accompanied by afforested belts of mixed oak and pine, run in places from the edge of terrace furthest inland from the Volga as far as the ancient syrt terrace, for instance, at the Mayna River and from Stavropol as far as Sok and Kondurcha.

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The left bank of the Volga is divided into two main parts, clay solonets steppe and sands. It is especially necessary to single out these considerably smaller parts: the steppe terraces along the Volga, the floodplain of the Volga, and its delta. The argillaceous steppe is characterized by the preponderance of solonetz complexes, formed on top of the deposited Caspian transgression (which is primarily of Khvalinsk type). It sends out tongues towards the North along the valleys of the Uzen' and Eruslan rivers, and extends continuously up to the low heights that separate these valleys, and to the southern end of the Great Syrt, at an elevation of about 30 meters above sea level, from there falling off gently towards the South.

The eastern part lies at the foot of the Great Syrt. Only a few streams that dry up during the Summer (the Dyura, the Chizhi, and others) traverse this plain, and since their beds are shallow, they always overflow in the Spring and water it. The eastern part is thus distinguished by a considerable number of naturally watered floodlands. A detailed survey of the floodlands on the Chizhi showed that where the depth of

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the channel was insignificant (20-30 centimeters), the depth of the water in it remained between 10 and 30 centimeters for a month or more, but that where the channel was deeper, the same amount of water remained until the middle of the summer, reviving vegetation, while at the same time soil salts were also brought up towards the surface.

The whole set of relationships between soils and vegetation is very complicated. On the plain, where the flood waters do not long remain, saline light-colored chestnut soils predominate (in slightly lower location), together with solonetzes of columnar structure interspersed with little mounds in front of marmot-burrows. In places flooded to only a slight depth, there are incrusted solonetzes in complexes with solodi and solonchaks. The latter represent to some extent a transition to the humified meadow soils, grow grassy vegetation and represent the most valuable hayfields and pastures. More low-lying floodlands, where the elevation of the bottom is 4-5 meters above sea level, have more or less salinified dark meadow soils, which at the same time are humified. Obviously two opposing processes are taking place here, and sometimes alternating with each other: on the one hand leaching and humification, with the accumulation of humus, in the different stages from solod to solonetz; while, on the other hand, salinification takes place by the aid of capillary displacement of saline waters to the surface in hot weather.

The Great and Little Uzen' rivers still have rather deep channels when they enter the plain (especially the Great Uzen') and they carry the spring waters as far as the basin of the Kamyshin-Samara lakes. Consequently the plain in the downstream areas of these rivers is less rich in floodlands. There are also spring-fed salt lakes (Lake Sakryl) between the two Uzen' Rivers. Still there are a few settlements even here in the floodland area.

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The central part of the plain is distinguished by the presence of many saturated saline lakes and salt mud-holes and bogs among the saline complexes of the steppe, which extend in a belt to the south into the area of the Caspian coastal sands.

The western part of the plain adjoins the Volga terrace. Here again solonetz complexes dominate the scene, in places with a considerable number of grass-covered or underbrush-covered hollows with dark chernozem-type soils, which are coming under cultivation. Here too large and small liman are encountered - depressions where water stagnates and soils become humified, leached and even, to some extent, swamped, and also, at the edges, usually extremely salinified.

The Caspian littoral sands on the left bank of the Volga occupy an immense area - about 4,000,000 hectares in all - and extend down to the shores of the sea. There are bare, wind-swept expanses (barkhan, kochugur, chapil, etc.) where the hillocks reach heights of 50-100 meters, and usually of 10-15 meters; and there are also sandy steppes with hard surface (kungur), passing over into saline sandy steppes, surrounded by salt mud-pools (khaki).

The wind-driven sands and the waters beneath their surface are mostly not saline; and among the bare hillocks there are often hollows with more or less vegetation and level surface, suitable for pasture.

The part of the plain at the approach to the Volga represents a somewhat raised portion, joining with the high Volga terrace. Solonetz soils are less prevalent here, while sandy loam, loamy light chestnut, or light chestnut soils predominate. In the low-lying part near Astrakhan a good deal of the land has been overgrazed and the soil can be blown away.

The floodplain of the Volga in the downstream areas, along the Akhtuba River and other Tributaries, is largely covered with sandy-

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muddy stratified alluvium, with a high water table and occasional surface salinification.

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A whole group of plants, with limited cycles of life above ground, inhabits the region of sparse grass vegetation in the dry steppe. A number of annuals complete their development earlier than the steppe vegetation, as for instance among the mustard family, the peppergrass (Lepidium) and hurachka (Alyssum); among the annual grasses, couch grass (Agropyrum) and bachelor's button (Ceratocephalus), etc. Similarly with the development of the underground part of perennials like tulips, lyutik (Ranunculus pedatus, R, polyrhizus), goldenrod (Adonis), milkwort(Euphorbia undulata), and the monthly grasses (Poa bullosa and Colpodium humile). All these plants annually form a shallow root system, which only draws on the surface part of the soil for nourishment; while with the monthly grass Poa Bullosa, in the dry season, during its period of summer quiescence, isolated shoots that still remain alive in the dessicated sod may be freed by grazing animals and spread over the surface of the steppe to reproduce. Such methods of migration are practised by numerous other steppe plants. Here one finds the lichens (Parmalia, Cetraria and others) and the algae (Nostoc) whose normal habitat is on the ground. But on the steppe, covered with wormwood and tipchak grass(Festuca sulcata), on the clayey soil of the southernmost and most desert expenses, they give an example of quiescent forms, drifting around during the period of drought and resuming their vegetative functions during the infrequent periods of moisture. With many other steppe plants, their extensively ramified portion above the ground dies after ripening of the fruit, and, leaving the soil, is transported by the wind to scatter

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its seed. Instances are the saltwort (Salsola), usterikhvost (Ceratocarpus) and petrosimonii (Petrosimonia).

The depressions on the steppe plain afford place for a most luxuriant growth of grasses; if the soil is sufficiently leached, more northerly types from the wooded steppe may find refuge there. Or if there is an accumulation of chlorides and sulphates in the soil, the groups of saline plants will flourish in it instead, from wormwood, marsh rosemary, and saltwort to the grasses akmamyk (Atropis distans), vostretsa (Agropyrum ramosum), and others. These flat, closed-in depressions, extended over a very considerable area and serving to drain the spring waters from the surrounding steppe, are called liman and serve as hayfields as well. Such liman may be swamped, and may even have open and permanently standing water.

In addition to the solonetzes which feature the floodplains of the small rivers, we should also note the widespread distribution, in the South, of solonetz areas covered by clusters of black wormwood, - the so-called karadzhyusan or Artemisia pauciflora - in contrast to the green coloration of the leaves that mark the preceding areas. Black wormwood represents almost the only growth on the solonetz soils here. These soils however, though they occupy extensive areas, are not encountered in the form of unbroken expanses but are associated with other formations, making up a complicated mosaic according to the distribution of the soils, which in turn is dependent on the detailed configuration of the terrain. More extensive depressions with grassy vegetation may be encountered in these associations, as well as solonchaks and salt lakes. Squat, stunted brush is met, spread out flat on the surface of the solonchaks. This vegetation is composed of plants with local names: sarsazan (Haolochenum strobilaceum), kokpek (Atriplex canum), bogorchun (Anabasis salsa) and a number of other Asiatic desert

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plants, which together form a discontinuous patchwork cover. These plants possess a number of adaptations to assist in the struggle with the dryness of the atmosphere, such as succulence and pilosity of the leaves, a waxy film, and so forth. The annuals develop their vegetation on the solonchaks in two different ways. They may either grow to maturity in the very earliest Spring, like the frankenia (Frankenia pulverulenta) or the tetradiclis; or else they may begin their growth in the Spring and bear their mature fruit in the Autumn, like the glasswort (Salicornia herbacea) plants noted on the solonetz soils of the river valleys, beginning with the former Kerdob Uyezd and Balashov Uyezd, on the right bank of the lower Volga, and with the former Pugachev Uyezd, on its left side.

Over the sands of the Volga and its important tributaries are spread specific grass forms which serve as the pioneers of vegetation to grow on the new sandy deposits, followed in time, when these deposits have been built up, by arboreal forms. Among the former group, the podbel (Petasites tomentosus) deserves our attention. This plant is equipped with a long dendritic root system which sinks into the sand and develops abundant accessory filamentous roots. Above the surface, thick triangular leaves, bordered with gray down, grow out of the stem. Many forms of willow and poplar, silver and black, are encountered among the tree species that subsist on the sandy littoral. They grow up rapidly after planting, and readily send out root filaments from the under-water section of the trunk. During high water in the downstream Volga areas, some willows also succeed in sending out such root filaments on an extensive scale, in the form of a continuous screen (below Saratov, at a level of the truck 2-2.5 meters above its base). Poplars and willows also have another characteristic, that of sending

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out shoots from the roots, by means of which mechanism a single tree may yield a whole clone.

Sandy deposits of aeolian origin sometimes reappear, when the vegetation cover of the sands is destroyed in consequence of bad management. To some extent this is the origin of the shifting sands along the Yeruslan River. But here and further to the south, as in the former Dukayev Ord and in the KAIMOBLAST, there are wide natural areas of sand, devoid of vegetation, with sands continually shifting under the influence of the wind. Among the grasses, the kumarchik (Argophyllum arenarium), an annual of the halophyte family, sends out very ramified stalks above the ground, which die after maturation of the fruit and are torn up by the wind, becoming "field-jumpers," and scattering their seeds along the way. The kumarchik can serve to anchor the sands, but only during the growing season, and not for longer than a single summer. Wild rye (Elymus sabulosus), a heavy tough grass, can also serve to anchor the sands and check drift. It forms a tall and massive sod, and when fixed in the sand it is able, if there is a certain amount of moisture, to produce abundant root filaments from the stem at the places where the leaves are attached (the nodes). These filaments aggregate the sands around it to such an extent that they are repelled and the stalk of the plant is no longer in contact with them. The willows, which have already been mentioned, also belong to the group of plants that anchor or aggregate the sands. Among them are varieties that live under more torrid conditions, such as Salix purpurea, S. rosmarinifolia, S. caspia, and others. A number of shrubs of the buckwheat, tamarisk and other families should also be mentioned in this connection.

The flora of stony and rocky habitats is very often distinguished from the cover on adjacent level (plakorniy) areas by the presence, in

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the former, of forms absent from the latter. This is particularly true of lime, marl and chalk soils located on slopes, mainly facing south. Among the flora of these slopes there are weeds, steppe plants, and finally, a large group of forms invariably confined to stony, calcareous and cretaceous substrata. The presence of weeds here is due to the influence of man; the presence of steppe plants may be explained by their position, more normal for them, in the northern forested localities. The origin of vegetation specifically belonging to cretaceous environments may be explained either as a survival from the glacial period or as a consequence of the cultivating activity of man. Among a number of these plants, its mountain character should be noted, as in the case of Aster alpinus, Globularia Willkommii and others; and there are also many Eastern desert varieties, such as Anabasis cretacea, Seseli tenuifolium, and others.

In the North of Lower Povolsh'ye the sandy areas of pine-grove vegetation sometimes adjoin peat-bogs where the continuous cover of peat-moss affords lodgment to northern varieties of willows, heather, sedges, rushes, sundews and so on. Sedges and grasses grow in the more southerly swamp areas, with sedge-covered hillocks and thickets of reeds and rushes. The Transvolga liman represent depressions in the level areas and may contain water, which sometimes remains for the whole summer in the central parts of such liman, or else evaporates at the end of the growing season. At times this water is more or less saline. The vegetation is of course different in the former and latter cases. A grass cover springs up on the flat liman of the Transvolga, early drying and occasionally occupying large areas. In some cases, usually in the more northerly locations of the steppe, couch grass (Agropyrum repens) predominates in the liman flora, while another grass - vostrets (Agropyrum ramosum) flourishes on the liman of the more

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southerly steppe, in the zone of wormwood and Festuca sulcata. Both types of liman are most valuable hayfields.

The aquatic flora of both closed and tributary ponds is rich in variegated species, differing according to the composition and condition of the water. Types of pond weed, water lily, and water buckwheat, which are fast to the bottom of the water, are common in pools along the shore of the rivers; while rogolistniki (Ceratophyllum demersum), completely rootless and flowering under water, or bladderwort, displaying their yellow blossoms above the surface of the water, alternate in saline waters with such plants as ruppia (Ruppia maritima) - plants of the coastal waters, which are also found in desert localities, far from the sea, as for instance in rivers flowing into salt lakes (Altun, for example). Still other varieties of rogolistniki - the naiad varieties (Najas, Caulinia Zannichellia) - appear on the liman of the lower terrace, above the meadow, or in other places of the valley (on the il'men areas of the downsteram Volga). Here many peculiar plants are encountered, such as the lotus of the Volga delta (Nelumbo caspicum), the insect-eating al'drovandiya (Aldrowandia vesiculosa), the vallisneria (Vallisneria spiralis), the water caltrop or water nut (Trapa natans), the water polypodiaceae (Salvinia natans, Marsilia quadrifolia, M. aegyptiaca, M. strigosa), and others which are numbered among the remaining survivors of the earlier prehistoric flora.

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The level surface of the southern part of the Transvolga comes to acquire a complex, semi-desert character with the increasing salinity of the soils. This character consists of three different environments, distributed in the most complicated combinations and juxtapositions as the result of slight variations in the relief, as is the

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case with much areas on the right bank of the Volga as well. The environments in question are the wormwood-Festuca salsata-black wormwood solonets, the grass-covered depressions, and the liman, the largest in area of all the depressions. Some of the liman are overgrown with reeds, sedges and grasses and have water during the entire growing season, while others dry out and are occupied by thickets of couch grass or vostrets (Agropyrum ramosum). When the beds of these liman are only slightly leached and their waters are rich in salt, their vegetation is different again. In such cases, the soils are in general solonchaks, and the plant growths are characteristic of desert habitats. The Kogut liman may serve as an example of liman in the Transvolga. Its vegetation is distributed in concentric zones. From the complex wormwood-grass vegetation of the surrounding area, successive zones of akmamyk (Atropis), marsh rosemary, reeds, couch grass, and finally, rushes, follow each other from the periphery toward the center. The aquatic vegetation in these liman is characteristic, consisting of rogolistniki (Ceratophyllum demersum), bladderwort and aquatic polypodiaceae. All such grassy zones serve as sites for hayfields. Halophytic vegetation is distributed also along the shores of the salt lakes Altun and Baskunchak. The vegetation of the small rivers that flow into these lakes consists of reed and rush thickets by the waterfront, and of seaweed (Enteromorpha) and a few forms of aquatic plants (Ruppia maritima) in the water. A number of interesting plant immigrants from Asia are found on the kokpek (Atriplex canum) and wormwood covered belts along the banks of these lakes. One of them on Lake Altun is called chauchimuldik (Megacarpaea laciniata), while for another on Lake Baskunchak is the name shokur rhubarb (Rheum tataricum). Both of them have thick tuberous roots; the former is used for food by the local po-

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pulation, and the latter for medicinal purposes. The development and advance of quicksands (shifting sands?) in this area (barchan and kochugur) may be checked by means of a large group of trees and grasses specifically adapted to the purpose. The control operations use willows (Salix purpurea, rosmarinifolia, caspica), grasses (Aristida, Elymus) and other plants. There are thickets of shrubs (Calligonum and Tamarix) in places here, which have been planted to anchor the sands.

The vegetation of the floodplain part of the Volga valley is represented by forest, steppe and meadow plant associations, besides the aquatic and swamp vegetation. Along the valley to the mouth of the river this vegetation tends to be rather less extensively distributed than that on the delta outside the floodplain. Nevertheless, the composition of the flora changes when the delta is reached. Here most of the tree species - typified by the oaks - are lacking. On the other hand, the so-called Baer hillocks are widespread in the delta zone. They are occupied by forms of desert vegetation, among which there are types of solonets and desert-sand habitats.

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THE ARAL-CASPIAN LOWLANDS

The Aral-Caspian lowlands, which occupy a very important part of Lower Povolzh'e, are distinguished by the simplicity of their geological structure and the almost total absence of dissection. A few outcroppings of older strata are exceptions: the Ulagan mountains, the Great and Lesser Bogdo, Chapchachi, the low karst plateau of Bishchokho in the Transvolga, and the Dabangol ravine in the Kalmyk steppe. In as much as the Aral-Caspian transgression is of marine and fresh-

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water character, consisting of more or less horizontally aligned yellowish-brown clays and loams, covered by a layer of loess-type clays, with sands on the South, the Aral-Caspian lowlands are also distinguished by relatively uniform and shallow positions of the water table, which ranges from 4 to 6 meters in depth. As a rule the ground water is mineralized to a considerable degree. The rivers are exceedingly small, and the very numerous lakes are the most typical hydrological formations, representing as they do various stages of development and varying degrees of mineralization, from freshwater to complete natural salinity. A very characteristic hydrological feature of the region is the area of the Kamysh-Samara terminal lakes, which receive the waters of the Great and Lesser Uzen' Rivers - rivers that carry the thaw waters, in spring, mostly originating in their watersheds within the confines of the Great Syrt.

The soils of the area, being geologically very young, contain large quantities of salt. Because of the exceptionally small gradients and the absence of rivers flowing into the sea, the processes of leaching proceed very slowly, and, for the most part, by way of the transfer of salts to the terminal lakes, salt mudflats, and salt marshes. The soil and botanical conditions are closely dependent on the degree of salinity displayed by the different parts of the locality, and these conditions also reflect the detailed configuration of the terrain, which is of tremendous significance on this flat land. The vegetation varies from the Festuca sulcata-mugwort type to the typical saline. In the northern part the soils are chestnut, in the southern part, light chestnut. Structured solonetzes are widely distributed in the North; and solonchaks in the South, whose formation is exceptionally favored by both hydrometeorological and soil-ground characteristics of the

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Aral-Caspian lowlands. The latter soils are widely distributed on higher places, where they are in the leaching stage, and on lower places, where they are in the stage of growth, towards higher salinity. Only from the sandy expanses are solonchaks absent, thanks to the special properties of sands. Both dry and wet solonchaks are encountered. The considerable distribution of takyr must also be noted.

Besides this major element of the landscape - the solonchaks - which are unquestionably the formation in which water conditions play the decisive role, the takyr, which are also closely associated with water conditions, are widely distributed as well. There is even a higher development of this formation, from the hydrological point of view, the sor, otherwise called khaka. These are unsaturated salt marshes, situated in the lowlands and fed by their own more or less important watersheds. They are difficult to traverse, full of hillocks, retaining a dense brine in the summer and depositing salts. Sor are especially widely distributed over the Left-Bank, Transvolga part of the Aral-Caspian lowlands. The highest stage of development of this order of hydrological formation is in the salt lakes, which, like the sor, have their own watershed basins. These salt lakes are usually surrounded by sor, and the transition from one to the other is often so imperceptible that the same body may sometimes be called a salt lake and sometimes a sor.

The salt lakes are spread over the same general region as the sor. The largest of them are the well-known Altun and Baskunchak, further the Great and Little Bakryl, the Stepanov Lakes (these latter being in the Kamysh-Samara lake system), and others. In the basins where salt lakes are located, ground waters often issue in the form of springs feeding these lakes with salt water, or sometimes with fresh water. In a few river valleys sources of ground waters are also encountered. However, springs are of infrequent occurrence and do not characterize the

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Aral-Caspian lowlands.

We consider next the very important hydrological formation of the salt and freshwater lakes, usually terminal lakes, which have water the whole year round, and are regularly fed by the rivers, principally at the time of the Spring high water. These rivers as a rule carry water from the adjoining moister regions in which their watersheds are located. Among the lakes of this type, the most noteworthy are the Kamysh-Samara group of lakes, connected with the two Uzen' rivers, and the Sarpin group of lakes, fed by the small rivers emptying into the Yergen' river. Both these groups play an essential role in the landscape and the economy, for settlements and fisheries depend upon them.

The Kamysh-Samara lakes, which are many in number during the dry seasons of the year, merge into one huge lake in the springtime, especially in years of high water. These lakes are small; in ordinary years the greatest depth at their centers is only two meters. Small parts of the lakes are covered with reed thickets. The freshwater lakes are rich in fish. The central lakes are surrounded by a large number of small peripheral lakes, which dry up in the summer and remind one of the appearance of the sor, but differ from these in that they are remnants of much more extensive spring lakes. The impermanency of these lakes must be noted, as they sometimes undergo intensive absorption by the sands which immediately adjoin on the south and east, and there are very considerable fluctuations of level, within the same year as well as in years of different water conditions.

The Sarpin lakes are disposed in a belt 175 kilometers long along the bench of the Yergen' River. They represent a very elongated reservoir, fed by the spring freshets from the little rivers that empty into the Yergen'. These lakes are divided into two chains - a nor-

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thern, running mainly north and south (Lakes Prishib, Barmantsak and Tsatsa) and a southern, running from northwest to southeast (Lakes Ungun-Tereche, Khanata, Tsagan-Nur and Tsabdyr). The lakes of each chain may unite among themselves in the spring of each year if there is enough water to overflow them; but the chains themselves do not merge, as they are separated by a relatively high divide. When the lakes of each chain are over-filled, a current is noted flowing northward in the northern chain, and toward the southeast in the southern chain, (Suvorov, 135).

The salinity of the lakes increases with the distance from the Volga. The northern (Caspin) lakes are fresh water, becoming slightly saline towards the end of summer, and rich in fish. The southern lakes are saline, and among them the Priyutnoe and Manych chains should be noted. Going southward, with the increasing salinity of the lakes, the number of permanent lakes diminishes; and approaching the East the lakes of the Manych chain alternate with salt marshes which are inundated by the freshets of the spring.

In the Caspian littoral region, the number of saline lakes and salt marshes is very large; and the southern part of the Kalmyk steppe is distinguished by the complete absence of life and even of nomadic population. With increasing distance from the Caspian towards the northwest, the number of salt marshes diminishes, the soil begins to be more leached, and the halophytic vegetation gradually passes over into the Festuca sulcata - wormwood, and finally, in the northern part of the Kalmyk steppe, it is of a "kovyl'naya" character. This circumstance testifies to the improvement in hydrological conditions from southeast to northwest.

The so-called il'men are distributed in the immediate vicinity of the downstream areas and delta of the Volga. These are lake forma-

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tions, closely connected with the Bgrovskiy hillocks. In the hollows between these hillocks ponds are formed, drawn out in a transverse direction and annually replenished by the flood waters of the Volga. The water in these ponds is fresh, and is strongly overgrown with aquatic vegetation, mainly reeds. The il'men which lose contact with the Volga become transformed into salt lakes, and then into salt marshes. On the Caspian littoral salt lakes are very numerous.

The liman are an extremely important hydrological formation in the area of the Aral-Caspian lowlands. This name is applied to shallow basins, periodically fed by spring thaws. The water here lasts for very considerable periods and reaches depths as great as 1.5 meters, usually drying up and being absorbed by the ground towards the middle of summer. Thanks to the high permeability of the ground, these spring waters percolate to deeper horizons and leach them, which favors the formation of chernozem-type soils and the growth of excellent meadow vegetation in the liman area. In addition to the great agricultural significance of the liman as hayfields, they also yield good ground water, annually renewed by the supply from the spring thaws and annually percolating through the soil again. Besides the liman with their own watersheds, which are especially well distributed over the Torgun (south of the Yeruslan River), the Altun and the Kundrov steppes, there are also a number of river-fed liman. These latter are located along the channels of the Uzen' Rivers, and merge with the yerik-channels of the latter. Such liman are essentially similar to the first type discussed, and differ only in their sources of supply. The spring floodwaters of the Uzen' Rivers pouring through the yerik annually fill the liman with fresh water, similarly vanishing during the su mer, similarly making possible the development of lush grass vegetation.

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The northeast corner of the Aral-Caspian lowlands, at the edge of the Lower Povolzh'e, is characterized by so-called floodlands (raslivi), the hydrological peculiarities of which mark a rather extensive tract running northeast from the Uzen' rivers, and in places crossing over the boundary into the Lower Povolzh'e. The little rivers running down from the southern slope of the Great Syrt - the Chizhi, Dyura, Solyanka and others, lose their channels in the broad level steppe, remaining only in possession of numerous shallow depressions. In the spring huge quantities of water from the melting snows pour through these small rivers and inundate the steppe with a broad cover of water, filling the depressions and then, as they are filled, advancing further to the south, irrigating the steppe over a considerable expanse, forming numerous liman and giving rise to the picture noted above by moistening, leaching and reviving the steppe. These expanses are known by the term floodlands (raslivi); we may note among them the Chizhi, Dyura, Balyktin and Akkus floodlands, fed by the small rivers enumerated above. Among the floodlands of the Uzen' system, the immense Slomikhin floodlands on the Great Uzen, and those which belong to the Kamysh-Samara chain of lakes have the richest hayfields and deserve attention.

Among the larger and more thoroughly studied rivers of the region, the Great and Little Uzen' are very typical of semi-desert conditions, both in their morphological characteristics and in their regime. Their watersheds, which extend beyond the confines of the Aral-Caspian lowlands, exert no particular influence on the regime, in the sense of causing any change in their character of semi-desert rivers, in as much as these watersheds furnish water only in the springtime, during the season of melting snows. The occasional springs encountered in the river valleys have no significant effect on the total runoff, since they only flow here and there, and the water is usually saline.

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While they remain within the limits of the Great Syrt area, the rivers have well-developed, normal valleys of considerable depth and, as is usual with steppe rivers, have reaches of salt water in midsummer. But as soon as they debouch upon the plain they change their aspect, flowing through shallow gullies with sheer walls. They have no more valleys in the usual sense. The river banks in the plains area are slightly elevated above the surrounding steppe. Very occasionally reaches bearing bitter brines may be encountered in midsummer. Wide belts of salt marsh frequently run along both banks. The channel sometimes narrows down to a mere groove as it passes through floodlands, resuming its original dimensions more or less, further downstream. The rivers have very few tributaries, and the beds of these few are exceptionally dry. Among the rivers of this type, besides the Uzen', the Gor'kaya and Solenogor'kaya may be mentioned. There are no rivers at all on the Kalmyk steppe; and only in the vicinity of the Yergen' is its surface intersected by numerous small channels which are extensions of the small rivers emptying into the Yergen'. This is particularly noticeable in the southern part of the steppe, where there are no terminal lakes.

Sands (the so-called Kyn'-sands) are widely distributed within the limits of the Aral-Caspian lowlands. In the Transvolga they occupy immense areas of the Bukeyev and Kundrov steppes, and on the Kalmyk steppe, the expanse running south and southwest from Yenotayevsk (Andryk). These sands are either anchored by vegetation in the hillocks, or they are loose and free-drifting. The sandy wastes are distinguished by the complete absence of any hydrographic system. There are neither rivers nor lakes. Only on the Caspian littoral, cut up into small coastal segments by the sea, do lakes exist at all, very impermanent and surrounded by the drifting sands. In contrast to the

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argillaceous semi-desert sands, the sands in this littoral area usually contain rather abundant stocks of fresh ground water, making it possible to develop very varied and rather lush vegetation on the stabilized sands. The fresh ground waters are fed by the Spring thaws, by inundations and, very probably in view of conditions in the sands, by condensation of atmospheric moisture as well. Another interesting hydrological formation should be remembered: the so-called "under-sand" lakes - former lakes which have been swallowed up by advancing sands but still continue to exist as reservoirs containing water beneath the sands.

The above noted hydrological subregions into which the Aral-Caspian lowlands are divided are characterized by the existing of the following hydrographic forms:

(a) The Torgun, Altun, Kundrovsk and Kalmyk steppes: salt marshes, takyr, sor or khaki, natural salt lakes, fresh and salt terminal lakes, liman, and infrequent rivers which run dry in summer and usually have their entire basins within the area of the lowlands.

(b) The floodlands of the Uzen', Chizhi and Dyura rivers: floodlands, liman, and rivers with watersheds outside the area of the lowlands.

(c) The sandy Caspian littoral desert of the Mukeyev (kyn'-sands) and Kalmyk steppes: absence of rivers and lakes, supplies of fresh ground water, and lakes beneath the sand.

(d) The subregion of the Barovskiy hillocks: il'men and salt marshes.

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THE YERGEN' RIVERS

A narrow belt of the Yergen' Oblast, extending from the city of Krasnoarmeysk to the Eastern Manych, also belongs to the territory we have described. It is bounded on the south by the watershed between the eastern and western branches of the Ergen', on the east by the boundary of the Yergen' shelf - the erosional platform of the ancient Aral-Caspian basin. The eastern branch of the Yergen' crosses numerous small rivers and ravines emptying into the so-called khudzhyr (narrow lakes) of the Aral-Caspian lowlands, into the Sarpin lakes on the north, and losing themselves to the south in the extensive salt marshes and seasonal ponds. These small rivers are seldom longer than 50 kilometers, and usually from 20-25 kilometers. They are distinguished by their straight courses and steep gradients. The Ergen' Rivers, having a considerable elevation above the level of the Aral-Caspian lowlands, flow downwards towards the north. They are distinguished by more favorable hydrometeorological conditions, especially by higher precipitation. The dissected eastern branch of the Yergen' uncovers aquiferous horizons in the river valleys and ravines, and for this reason there are numerous springs and sources. In as much as the Yergen' Rivers are bedded in sandstones, which are underlain by clays and covered by loess-type deposits, they receive considerable amounts of ground water, thanks to the relatively light penetration of precipitated waters - especially of the waters from the spring thaws - into the ground. A few of the valleys are fed with enough ground water to maintain a permanent flow in their channels, but the main source of water for all the rivers on the eastern slope is the spring thaw. From north to south the Yergen' Rivers become drier, the small tributaries yield less water, and the flow of ground water into the Yergen' diminishes. The valley of the

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Elista River marks the boundary between the moist northern zone of the Yergen' and the dry southern zone. The Elista is one of the tributaries with the greatest flow, and maintains a flow throughout the summer. Like all the small rivers to the north of it, it is a fresh water stream. The locality is sufficiently moist for land cultivation and arboriculture, and the river valleys are rather well populated. The valleys of some rivers - and of the Elista in particular - are blooming oases, with abundant water, in contrast to the salty Kalmyk steppe and especially to its southern part.

The rivers and ravines to the south of the Elista are distinguished by greater dryness. Rarely do they maintain a weak permanent flow of water, and they usually end in small salt lakes. South of the Ulan-zaukha River, which itself ends in such a little lake, there are a number of completely dry ravines, fed only by the waters of the spring thaws and terminating in extensive salt marshes.

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The highlands on the approach to the Volga, at the edge of the region, are divided into three subregions: Syzran-Ulyanovsk; Vol'sk-Khvalinsk; and Saratov-Stalingrad, which differ among themselves in the relative closeness of the rivers comprising their river systems.

THE VOLGA VALLEY

The floodplain of the Volga, in view of its very considerable dimensions, especially below the mouth of the Akhtuba, is a very outstanding geographic element in the Lower Povolzh'e, and possesses a number of peculiar features. Its geomorphological, hydrological and soil-botanical characteristics serve fundamentally to distinguish the valley from all the regions which it crosses. The basic factor, which determines all the other features of the floodplain landscape, is its hydrological regime, and in particular the influence of the

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Volga waters, which periodically inundate the floodplain, and also the high water table.

The first terrace, which is under the immediate influence of the flowing waters of the Volga, both at high-water and low-water seasons, is essentially a floodplain. The very energetic activity of erosion is reflected in the development of a specific floodplain relief, with elongated ridges and numerous channels, voloshek and verik. The steep banks, undercut by the current of the river, are a characteristic formation. Under the influence of the high degree of moisture in the floodplain, meadow and bog-meadow soils are formed. Extensive areas are occupied by sand dunes, both free and anchored by willows. Both types of dune are powerfully affected by the influence of the stream, and some of them are in the stage of being disintegrated and washed away, while others are still in the stage of accumulation and growth. Vegetation is lush, consisting of meadow vegetation and brushwood, with deciduous species of trees on the ridges. There are many ancient riverbed areas now covered with stagnant water, and also many floodplain lakes, which often merge with each other and with the verik-channels of the Volga.

The width of the floodplain is not uniform. Between Stalingrad and the mouth of the Kama, for a distance of 1000 kilometers, there are three contracted portions: at Balakov and Marksshtadt it is about two kilometers wide, at the Morkvash and again at the Zhigulev Mountains it is about three kilometers. In the broader parts the width may reach as much as 20 kilometers, while in the broadest part of all, between the Tetyusha and Ulyanovsk, it is about 30 kilometers wide. North of Stalingrad the Akhtuba branches off from the main stream of the Volga and runs roughly parallel to it down to the very mouth.

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In midsummer the Akhtuba near its divergence loses contact with the Volga, and maintains a permanent flow only through the Black Yar. There are many deep places in the Akhtuba, which reach depths as great as 20 meters. The width of the floodplain between the Akhtuba and Volga (Zaymishcha) varies from 20 to 40 kilometers. Along this stretch the Volga floodplain, passing along a salty semi-desert, is distinguished by the lushness of its flora and the complete absence of salinity. There are many lakes on the Zaymishcha between the Volga and Akhtuba, as well as ancient riverbed areas now covered with stagnant water, and also channels (yerik) joining the floodplain lakes with the Volga and Akhtuba. The annual inundations are a characteristic feature of the Volga floodplain, covering its entire surface and influencing the whole complex of physical-geographical conditions, especially the soils and vegetation.

The Volga floodplain is divided into two parts: the floodplain proper, above the divergence of the Akhtuba, and the Zaymishcha, together with the delta, from that divergence to the sea.

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A. RIVERS

1. General Information Concerning the River Network of Nizhneye Povolzh'ye

The river network of Nizhneye Povolzh'ye is formed principally of rivers belonging to the Volga basin. Besides them, there are to be found a number of non-discharging rivers which, on the left bank of the Volga, belong primarily to the Kamysh-Samara lakes basin, and which, on the right bank, flow from the eastern slopes of Yergeni, only to disappear on the Kalmytskaya Steppe (Kalmyk Steppe), where they, in part, feed the numerous lakes of the Sarpinskoye Ponizheniya (Sarpin depression).

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The Volga, as the principal artery, determines the physical, geographical and economic features of Nizhneye Povolzh'ye, entering within the scope of the territory under consideration only in the lower part of its basin. Out of a total area of 1,402,010 square kilometers (Tillo, 137), only that part below Kama, or 250,765 square kilometers, is considered, with only 1,850 kilometers of a total length of 3,694 kilometers (Perechen', VVP, 2294) entering this sector. In the territory of Nizhneye Povolzh'ye, the Volga has 22 tributaries, of which the 16 principal ones have a total length of 3,857 kilometers. Thus for every 1 kilometer of the Lower Volga's length there are more than 2 kilometers of tributary, while in the Volga's upper reaches (up to the Kama's confluence), there are 33.1 kilometers of tributary for each kilometer of length. These figures quite clearly bear witness to the basic hydrological feature of the Nizhneye Povolzh'ye -- its poverty with respect to flowing waters, not including the Volga itself, which acts as the principal carrier of the waters brought from outside this hydrological region.

The Volga's tributaries are distributed unevenly between its right and left banks, this being due to the basic features of the territory's orography conditioned by the close location of the water divide of the Volga elevation to the right bank. The following rivers flow into the Volga on its right bank: Meshkala (l = 170 kilometers), Chertala, Bezdna (l = 78 kilometers), Mayna (l = 88 kilometers, F = 1,570 square kilometers), Cheremshan (l = 388 kilometers, F = 11,720 square kilometers), Samara (l = 587 kilometers, F = 46,250 square kilometers), Chagra (l = 213 kilometers, F = 3,510 square kilometers), Malyy Irgiz (l = 175 kilometers, F = 4,260 square kilometers), Balakovka, Bol'shoy Irgiz (l = 571 kilometers, F = 23,880 square kilometers), Malyy Karaman (l = 94 kilometers, F = 873 square

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kilometers), Bol'shoy Karaman (l = 219 kilometers, F = 23,880 square kilometers), Tarlyk (F = 504 square kilometers), Yeruslan (l = 352 kilometers, F = 12,224 square kilometers), i.e., 15 rivers, while from the right bank there flow in only 7 rivers, -- Tushka, Usa (l = 106 kilometers, F = 3,340 square kilometers), Syzran' (l = 123 kilometers, F = 5,099 square kilometers), Tersa, Tereshka (l = 272 kilometers, F = 10,230 square kilometers), Chardym (l = 101 kilometers) (F = 1,104 square kilometers), and Kurdyum (l = 58 kilometers, F = 1,1006 square kilometers). The lengths of the rivers are given according to the "Perechen' VVP."

Moreover, the river network becomes poorer as one goes from the northern to the southern part of the Lower Volga Basin, so that the southern half of the Volga Basin may be considered as practically having no tributaries.

This decrease in flowing water as one goes from the northern to the southern part of the basin is a characteristic feature of the entire hydrologic region, and though there flow from the water divides of Obshchiy Syrt outside the Volga Basin into the region of the Kamysh-Samara lakes such relatively large rivers as Bol'shoy Uzen' and Malyy Uzen', yet this lake receives no tributaries from the south, in the same way that the Caspian Sea does not receive any between he Volga and the Urals. The extreme southern part of the region, the right bank Kalmytskaya Steppe (Kalmyk Steppe), is almost completely deprived of a river network. Only in its western limits are to be found a number of shallow streams, flowing down from the Yergeni elevation.

Without considering any further the general features of the hydrography of Nizhneye Povolzh'ye, which is described in greater detail in Chapter I of this book and is broken down by individual basins in the following description, it may at least be said that it would be

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a logical procedure to start this study by first beginning with the Volga, then going to its tributaries from the upper reaches to the lower, and finally writing up as individual sections the rivers belonging to the Kamysh-Samara lakes basin and the rivers of the eastern slope of the Yergeni.

It should be noted that in all cases where information on the lengths of rivers of the areas of their basins is given without an indication of the source, it is based on the calcualtions of the State Hydrological Institute (GGI) according to the 1:420,000 maps of VTU /Military Topographic Administration/.

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Table of Mean and Extreme Atmospheric Precipitations[1]

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Current Nos of Station List (p. 136)	Station Name	Observation Period[2]	Number of Years Observed	Monthly Precipitation in Millimeters I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Through the entire year	Computed over a 40-year Period Yearly Warm Cold	Warm Part of the Year (in percent)
1	Ozerki																	
6	Vodyanoy Buyerak																	
10-11	Kamyshin																	
17	Lipovka																	
21	Kargachev																	
25	Dubovka I																	
27	Dubovka III																	
29	Sredne-pogromnaya																	
30	Stalingrad																	
34	Tsatsa																	
36	Tinguta																	
38-39	Yelista																	
41	Yashkul'																	
42	Kuzovatovo																	
45	Kochkarley																	

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51 Shmitovka

52 Kologyar

54 Cherkasskoye

56 Karabulak

57 Barmukovo

61 Sutyagin Klyuch

63 Teplovka

64 Privol'skaya

67 Bazarnyy Karabulak

68 Vol'sk

71 Grachevskiy Khutor

73 Marksshtadt

74 Saratov Oblast Agricultural Experimental Station

75 Saratov

78 Engel's (Pokrovskaya Sloboda)

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80 Urbakh

85 Krasnyy Kut
(experimental field)

91 Malyy Uzen

92 Kostychev Experimental Field

96 Urda (Khanskaya Stavka

99 Akhtuba

102 Baskunchak

104 Chernyy Yar

106 Zolotuchino

108 Prishib

110 Sasykolskoye

111 Kopanovskaya

114 Yenotayevsk

116 Khosheutovskiy
Uchastok

120 Petropavlovka

121 Aleksandrovskiy Uchastok

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124 Oranzhereynyy Promysel

127 Biryuch'ya Kosa

129 Chetyrekhbugornyy Mayak

133 Tetyushi

134 Spasskoye Experimental Field

135 Bessonovo

136 Undory

138 Malaya Kandala

140 Terent'yevka

141 Cherdakly

142-143 Ul'yanovsk

145 Krestovoye Gorodishche

146 Novaya Malykla

148 Lebyazh'ye

152 Sengiley

154 Samorodnaya

162 Nizhneye Sancheleyevo

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163 Borkovskiy Khutor

164 Stavropol'

166 Usol'ye

167 Staraya Racheyka

169 Sosnovyy Solonets

171 Batraki

173 Staryye Kostychi

174 Syzran'

177 Bezenchuk

178 Olgino

179 Kamyshinskiy Khutor

180 Chastyye Kolki

181 Khvalynskoye Experimental Field

190 Pugachev

192 Malaya Tarasovka

193 Berezovo

196 Lyubitskoye

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198 Kochetkovo

200 Yershov

204 Kurilovka

205 Novouzensk

206 Aleksandrov-gay

207 Slamikhinskaya

212 Krasnyy Yar

214 Astrakhan'

219 Izgar

224 Mamykovo

225 Novyy Kuvak

226 Chernovka

230 Aksenovka

231 Isakly

233 Krasnoposelok

235 Sernovodsk

236 Mikushkino

239 Sukhiye Avrali

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240 Amanak

241 Malyy Tolkay

247 Bogdanovka

248 Timashevo

249 Novo-Klyuchevka

250 Kinel'

254 Tomashev Kolok

255 Zubchaninovka

263 Borskoye

266 Yefremovka

267 Usmanka

275 Perelyub

276 Yekaterinovka

279 Russkiy Kandyz

281 Korotkovo

282 Polibino

283 Klyuchevskiy Khutor

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284 Pokhvistenvo

285 Buguruslan

286 Tikhiy Khutor

287 Saray-gir

290 Popolutovka

291 Bashkatovka

297 Izmaylovo

298 Dmitriyevskiy Khutor

299 Kozlovka

302 Mogutovo

304 Borovoye Forest Administration, meadow

309 Buzuluk Railroad Station

311 Buzuluk Experimental Field

312 Aleksandrov Agricultural School

318 Novo-Sergiyevskaya

1) Italics show monthly and annual maximal and minimal precipitations

2) Respective years are indicated by their two last digits

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Annual Atmospheric Precipitations Expressed in Percent
of Mean Through the 1891 - 1930 Period

Year

1930

Number of Years 40

Note: In two last columns are given: (a) frequency in the form of ratio of number of stations with excess precipitation to the total number of stations observed through the particular year, and (b) mean precipitation for all stations in the respective line.

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Data on Snow Cover

Current Nos of Station List	Station Name	Observation Period	Multi-Annual Means	Multi-Annual Mean Annual Snow Durations	Maximal Annual Snow Cover in Centimeters
6	Vodyanoy Buyerak				
11	Kamyshin				
17	Lipovka				
21	Karagachev				
25	Dubovka				
29	Srednc-Pogromnaya				
30	Stalingrad				
36	Tinguta				
37	Kharakhusovskiy Ulus				
39	Yelista				
40	Yashkuly (Yelista)				
42	Kuzovatovo				
45	Kochkarley				
51	Shmitovka				
52	Koloyar				
54	Chorkasskoye				
57	Barnukovka				
60	Shirokiy Buyerak				
61	Sutyagin Klyuch				

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Data on Snow Cover

Current Nos of Station List	Station Name	Observation Period	Multi-Annual Means	Multi-Annual Mean Durations	Maximal Annual Snow Cover in Centimeters
63	Toplovka				
6	Vol'sk				
73	Ivanovka				
73	Turkmenbadt				
74-5	Saratov				
91	Malyy Uzen'				
96	Urda				
99	Akhtuba				
104	Chornyy Yar				
106	Zolotukhino				
108	Priob'ye				
114	Yenotayevsk				
116	Khosloutovskiy Ochistok				
119	Zaryanovskaya				
120	Petropavlovka				
122	Durnovskaya				
124	Orenzhoroynyy Promysel				
127	Biryuchya Kosa				
129	Chetyrekhbu_ornyy Mayak				

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Data on Snow Cover

Current Nos of Station List	Station Name	Observation Period	Multi-Annual Means	Multi-Annual Mean Durations	Maximal Annual Snow Cover in Centimeters
135	Bessonovo				
138	Malaya Kandala				
142-3	Ul'yanovsk				
145	Krestovoye Gorodishcha				
148	Lebyazh'ye				
152	Sergiloy				
163	Borkovskiy Khutor				
164	Stavropol				
166	Usol'ye				
169	Sosnovyy Solonets				
171	Batraki				
173	Staryye Kostychi				
175	Syzran'				
177	Buzenchuk				
184-185	Khvalynsk				
192	Malaya Tarasovka				
196	Lyubetskoye				
198	Kochetkovo				
209	Bakayevskiy Ostrov				
212	Krasnyy Yar				
219	Izgar				

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Data on Snow Cover

Current Nos of Station List	Station Name	Observation Period	Multi-Annual Means	Multi-Annual Mean Durations	Maximal Annual Snow Cover in Centimeters
225	Novyy Kuvak				
231	Isakly				
233	Krasnoposelok				
235	Sernovodsk				
239	Sukhiye Avrali				
247	Bogdanovka				
248	Timashevo				
250	Kinel'				
253	Rozhdestvenno				
254	Tomashev Kolok				
256	Neplyuyevo				
275	Perelyub				
276	Yekaterinovka				
279	Russkiy Kandyz				
282	Polibino				
283	Klyuchevskiy Khutor				
284	Pokhvistnevo				
285	Buguruslan				
286	Tikhiy Khutor				
290	Popolutovka				
298	Dmitriyevskiy Khutor				
299	Kozlovka				
304	Borovoye Forest Administration				

1) Winters are indicated by two last digits of the year in which they end.

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Table of Insufficient Multi-Annual Saturation for 1891 - 1930 Period

Monthly and Annual Maximal, Mean and Minimal Insufficient Saturation Values

Current Nos of Stations List	Observation Point	Observation Period	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
11	Kamyshin													
30	Stalingrad													
68	Vol'sk													
74-75	Saratov													
91	Malyy Uzen'													
92	Kostychevskaya													
99	Akhtuba													
124	Oranzhereynyy Prompysel													
127	Biryuch'ya Kosa													
129	Chetyrekhbugornyy Mayak													
134	Spasskoye													
142-3	Ul'yanovsk													
175	Syzran'													
177	Bezenchuk													
198	Kochetkovo													
200	Yershov													
205	Novouzensk													
214-15	Astrakhan'													
248	Timashevo													
254	Tomashev Kolok													
282	Polibino													
364	Borovoye Forest Administration													
309-11	Buzuluk													

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Table of Multi-Annual Absolute Humidity Means per Month and Year

Current Nos of Station List	Station Name	I	II	III	IV	V	VI	VIII	IX	X	XI	XII
11	Kamyshin											
30	Stalingrad											
68	Vol'sk											
74-77	Saratov											
91	Malyy Uzon'											
92	Kostychevskaya											
99	Akhtuba											
124	Oranzhereyryy Promysel											
127	Biryuch'ya Kosa											
129	Chetyrekhbugorryy Mayak											
134	Spasskoye											
142-3	Ul'yanovsk											
175	Syzran'											
177	Bezenchuk											
198	Kochetkovo											
200	Yershov											
205-5a	Novouzensk											
214-17	Astrakhan											
248	Timashevo											
254	Tomashev Kolok											
282	Polibino											
304	Borovoye Forest Administration											
309-11	Buzuluk											

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Note: Observation periods are indicated in the preceding table. In some cases in this table they are 1-2 years larger, since for the computation of insufficient saturation table was used somewhat shorter period of time.

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Volatility Table according to Wild's Evaporator

Current Nos of Station List	Observation Point	Observation Period	Number of Years Observed	Monthly and Annual Volatility in Centimeters I II III IV V VI VII VIII IX X XI XII	Through the
36	Tinguta				
91	Maly Uzon'				
92	Kostyclevskaya				
124	Oranzhereyny Promysel				
126	Kosuta				
127	Biryuchya Kosa				
196	Kochetkovo				
214	Astrakhan (school)				
217	Astrakhan (harbor)				
282	Polibino				

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Annual Volatility Table Computed by Meyer's Method

Current Nos of Station List	Observation Point	Overall and Diffusion Volatility per Month and Year in centimeters												Through the entire Year
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
11	Kamyshin													
30	Stalingrad													
66	Vol'sk													
74-77	Saratov													
91	Malyi Uzen'													
92	Kostychevskaya													
99	Akhtuba													
124	Oranzhereynyy Promysel													
129	Chetyrekhbugornyy Mayak													
127	Ikryanch'ya Kosa													
134	Spasskoye Experimental Field													
142-3	Ul'yanovsk													
175	Syzran'													
177	Bezenchuk													
198	Kochetkovo													
200	Yershov													
205-5a	Novouzensk													
211-11	Astrakhan'													
248	Timashevo													
254	Tomashev Kolok													

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Annual Volatility Table Computed by Meyer's Method

Current Nos of Station List	Observation Point	Overall and Diffusion Volatility per Month and Year in centimeters	Through the entire Year
		I II III IV V VI VII VIII IX X XI XII	
252	Pollbino		
304	Borovoye Forest Administration, Station No 2		
309-11	Buzuluk		

The data contained in the first line for each station represent the overall volatility. The second line gives data on diffusion volatility.

Translator's Note: "214-11 Astrakhan" should in all probability read: "214-17 Astrakhan" (See table on page 402).

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2. Volga River

(From the Confluence of the Kama to the Caspian Sea)

(a) Hydrography and Water Regime

General Considerations

The Volga enters the limits of Nizhneye Povolzh'ye from the point of the confluence of its largest tributary, the Kama, 1854 kilometers above its mouth. The basin of the Volga grows rapidly up to the confluence of the Kama. Below the confluence of the Kama the growth of the basin is slow, but it is faster for the right than for the left bank. The area of the Volga basin within the limits of the region under discussion (according to 1:420,000 scale map) is equal to 250,765 square kilometers, or 17.8 percent of its total area of 1,402,010 square kilometers (according to Tillo). The right bank includes 60,495 square kilometers (24 percent), the left bank 190,270 square kilometers (76 percent).

After the confluence of the Kama, the descent of the Volga is gradual without any sharp drops. Distribution of the gradients along the river (Tillo, 2347) is as follows:

Place Names along the Volga	Distance between points (kilometers)	Total Descent	Gradient
Undor	33	0.4	0.000012
Ul'yanovsk	59	2.6	0.000044
Sengiley	94	4.7	0.000050
Stavropol'	81	2.3	0.000028
Samara	122	4.5	0.000037
Syzran'	190	6.0	0.000031

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Place Names along the Volga	Distance between points (kilometers)	Total Descent	Gradient
Confluence of Irtis River	500	18.8	0.000038
Dubovka			
Mouth of Volga	660	10.8	0.000023

Drawing 2 shows an abbreviated longitudinal profile of the Volga sector from the confluence of the Kama to Astrakhan' according to data of "Opyuro Bol'shoy Volgi Giprovoda."

Mean gradients of the Volga for its delta section are given according to the months of the year in the following table (Baledinskiy 276):

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Place Names	Distance between points	Gradients (in millionths) by Months											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Stalingrad	492	30.4	29.9	29.5	30.4	37.3	36.1	30.9	29.7	29.2	29.1	29.0	28.5
Astrakhan'	87	6.8	7.5	5.4	6.5	22.3	30.6	15.1	8.5	6.0	7.1	7.2	4.9
Boasta	10	13.0	9.0	7.0	11.0	18.0	22.0	16.0	14.0	12.0	9.0	13.0	15.0
Biryuch'ya Kosa													
12th Foot Roadstead	67	-	-	3.3	4.9	6.4	6.9	3.9	2.1	2.1	3.1	1.5	-

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Drawing 3 shows an abbreviated longitudinal profile of the delta sector of the Volga along Bakhtemirovskiy Farvater (Bakhtemirov Fairway) according to data from the survey made in 1919-1925 by the Volga Port Survey Party (Baledinskiy, 276).

Volga from the Confluence of the Kama to Syzran'

Below the confluence of the Kama, the Volga flows westward for a distance of 40 kilometers and then sharply turns south. Below Ul'yanovsk it goes southwestward for a short distance, after which it flows south until it meets the Zhiguleveskiye Gory (Zhiguli Mountains), which throw it back far to the east. Having gone around the Zhiguli Mountains, it forces its way through the so-called Samarskiye or Zhiguleveskiye Vorota (Samara or Zhiguli Gates), after which it flows eastward to Syzran'. The length of the sector from the confluence of the Kama to Syzran' is 506 kilometers.

The Volga valley widens after admitting the Kama, being 21 kilometers wide at the confluence of the Kama with the Volga, and later, between Tetyushi and Ul'yanovsk, at the village of Undor, widening to 29 kilometers. About two kilometers below the village of Korolevka, the left elevated bank draws close to the Volga. Here the bed is only 3½ kilometers wide in spring. Further on, the high mountains of the right bank and the unfloodable elevated and hilly left bank recede, the bottom land widens, and about 10 kilometers below in the direction of the current it widens to 11 kilometers at the traverse of the village of Krasnyy Yar, and as much as 13 kilometers at the traverse of the village of Kremenka. Below at the traverse of Kriushin Island, the elevations of the right and left banks again draw near to the river and the bottom land narrows down to 4 kilometers. Still lower, at the Usul'ye sector, the river has bottom land

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on both sides. Here the main bed has not yet reached a permanent location. At the Zhiguli sector the river bed without deviation follows the mountainous and difficult-to-wash-away right bank, while on the left side it is limited by bottom land 1 to 3 kilometers wide. At the Zhiguli Gates sector, where both the right- and left-bank of the Zhiguli achieve their closest proximity, the bottom land of the left bank achieves a width of 1,070 meters. The full width of the river at the maximum spring flood in 1926 was here 2,320 meters. From the village of Krasnaya Glina to the lower boundary of Samara the Volga does not have a left-side bottom land. Below Samara, there begins a widened left-side bottom land, about 150 kilometers completely devoid of any large secondary channels.

The middle channel (ruslo) of the Volga achieves its greatest width at the sector from Undor to the bend (luka), that is, at the Palitsynskaya Volozhka (Palitsyn Channel), near the confluence of the Kriushinskaya Volozhka (Kriushin Channel), and approximately 5 kilometers below Buyeraki it becomes 1.7 kilometers wide. The channel (ruslo) is widest for the bend (luka) sector above Russkiye Lipyagi - 1.7 kilometers. The prevailing width here is about 1 kilometer; the narrowest is less than 0.5 kilometers near Sheremet'yevo.

The deepest mean depth for the sector from Undor to the bend is 23 meters at Undor. The predominating depth for the fairway varies within the limits of 8.5 to 15 meters, the shallowest depth being 2.3 meters at Akhtushinskiy Pereval (Akhtushin Pass). For the sector of the bend below the village of Pecherskoye the greatest depth is 18.5 meters, and about 17 meters at Stavropol'. The prevailing depths for the bend sector are 6-13 meters, the shallowest 4.3 meters.

For almost the entire length of the Volga, there are to be found, principally along its left bank, a large number of secondary

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channels, backwaters and dried beds. The principal ones up to the bend are: Palitsynskaya Volozhka (Palitsyn Channel), Krasnoyarsk, Gorodishche, Kriushin Backwater, Svinukha Volozhka (Svinukha Channel), Podval'skiy Backwater, Sukhaya Atruba Channel, Krivolushskiy and Goryachiy Backwaters. For the sector of the bend there are to be noted Sernyy Channel, Rozhdestvenskaya Volozhka (Rozhdestvenskaya Channel), Podshabinskiy Backwater and Yekaterinovskaya Volozhka (Yekaterinovskaya Channel).

Two kilometers below Zhirnyi Gates the bed of the Volga is divided into two channels by the bottom land, forming Sernyy Island. For the past 40-50 years the right Sernyy Channel, being considerably silted with sand, has been playing a secondary role. During the past ten years there has gradually appeared a wide left bank (pobochen') and at the same time there has been intensified the washing out of the right Sernyy Channel, which, after the flood of 1926, became the principal channel.

Somewhat further down at Barboshina Polyana there begins one of the principal channels, Rozhdestvenskaya Volozhka, which, in relation to the main channel, shortens by approximately 20 percent the route for the flow-off of high waters. The Samara Channel (Samarskiy Protok), newly formed within the past few decades, flows into the middle part of Rozhdestvenskaya Volozhka. The Volga threatens to divert its course into Rozhdestvenskaya Volozhka, inasmuch as the flow of water becomes stronger through it each year. The distance between the beginning and outlet of Rozhdestvenskaya Volozhka is 10 kilometers, while along the main channel it is 15 kilometers. Filling in (zanosimost') of the shore line at Samara is directly related to the Rozhdestvenskaya Channel which from year to year grows wider and deeper.

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The overflow of waters from the main channel into bottom land through the high flood channels is to be considered as an adverse manifestation. (The high flood channels are located opposite the Samara Roadstead.) As a result of the transfer of the fairway opposite Samara to the right bottom land shore there has resulted a considerable washing away of this shore, and the width of the main channel of the Volga near the city below Vozhdestvenskiy Channel (protok) increases each year, while at the same time its depth is gradually growing more shallow.

The distribution of the discharge of spring waters in the main channel of the Volga and in the right bottom land with its channels can be seen from the following table compiled from 1926 data of the Engineer Hydrologic Station of the People's Commissariat for Railroads:

Level in Meters	Discharge in Cubic Meters per Second	Distribution of Discharge in Percent In front of Postnikovskiy Ravine		Below Samara Channel of Vozhdestvenskaya Volozhka	
		Main Channel	Bottom land with Channels	Main Channel	Bottom land with Channels
15.63	60877	91.7	8.3	83.9	16.1
12.76	33203	89.1	10.9	78.1	21.9
11.26	25985	91.5	8.5	78.5	21.5
2.83	5078	100	-	90.6	9.4

The maximum flow-off of water into the bottom land through the Samara Channel accounts for a drop of 12.76 meters in the water level. With higher and lower water levels the amount of flow-off decreases. For average mean water levels, almost the entire flow-off is done through Samara Channel.

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Volga from Syzran' to Akhtuba

For the sector from Syzran' to Akhtuba Channel, 764 kilometers in length, the Volga holds to a southwesterly direction and flows past a wide bottom land, holding to the right bank, and approaching the left side of the valley only at Marksshtadt and Engel's (formerly Pokrovsk), Novnoye, and Dykovyye Khutora. The width of the river at Marksshtadt during the flow of spring waters is less than 2 kilometers. During summertime the water is contained in one channel whose width is about 1.8 kilo eters. Further down the bottom land widens, reaching 15 kilometers at Chardym. Further on towards Saratov it narrows down to 5 kilometers. Below Saratov at Uvek the Volga waters recombine to flow along one bed.

The width of the middle channel varies throughout its entire length from 0.5 to 2.2 kilometers. Its greatest mean depth along the sector from Syzran' to Akhtuba is to be found at Khvalynsk and the confluence of the Malyy Irgiz, where it reaches 22-22.5 meters. Above Zolotovskiy Backwater the depth becomes 20 meters. In other places the depth for stretches varies between 8 and 15 meters. Its shallowest depths are along the sand shoals, of which there are 46 between Syzran' and Akhtuba at the Vol'sk-Saratov sector. Here, between the confluence of Chardym and the confluence of Tul'skaya Volozhka (Tul'skaya Channel), the Volga has an average mean depth of 1.8 meters. Opposite Tayurikh, below the confluence of Bol'shoy Karaman River and at the beginning of Tul'skaya Channel, the depth along the fairway is about 2.5-3 meters. In other sectors the depth exceeds 3 meters.

Throughout the entire distance from Marksshtadt to Akhtuba the bottom land of the Volga is broken up by the various channels (protoki, volozhki) into islands, some of which make up clusters.

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The length of individual islands can be as long as 10 kilometers. The principal channels to be found here are: Devichnaya above Vol'sk (right bank), Tul'skaya at Yel'shanka, Vorovskaya (left bank) at Podstepnaya Colony, Tarkhanka at Saratov, where there are also Pokrovskiy and Saratov backwaters, Karavainskya at Rykovyye Khutora, Balykleyskiy at Balykley, Oleninskaya at Oleni, Pogromenskaya at Dubovka and the beginning of Akhtuba Channel at Chernyy Rynok, 631 kilometers from the mouth of the Volga.

The channels of the Volga, having uneven velocities where they cross and meet, throw off silt which form shoals, which are sometimes large and which present a hazard for shipping. It is interesting to note that Tarkhanka, a channel of the Volga at Saratov, was once the principal bed, but at the present time is a channel with an insignificant flow of water. The silt deposits in the Tarkhanka from Pokrovskiy Channel, which has a faster current than Tarkhanka, make it difficult to approach Saratov through it.

The Volga from the Beginning of the Akhtuba to the Beginning of the Buzan

After the branching off of the Akhtuba, the Volga preserves its initial southwesterly direction up to Krasnoarmeysk (formerly Sarepta). Further on the Volga turns southeastward and flows along this direction to the villages of Petropavlovskaya and Lebyazh'ye, below which is generally considered to be the beginning of the Volga delta.

This sector is characterized by a total absence of tributaries (with the exception of small drying streams) and a wide river valley. Its width at Krasnoarmeysk reaches 32 kilometers, narrowing down to 16 kilometers at Kamennyy Yar and 19 kilometers at Chernyy

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Yar. Above Vetlyanskaya village the width of the valley is 9.5 kilometers. Then the valley widens, and, 11 kilometers below Yenotayevsk, it becomes 30 kilometers wide, while after the beginning of the delta it widens to more than 50 kilometers. The width of the main channel varies: at Stalingrad it is 2,000 meters, at Krasnoarmeysk 450 meters, below Solenoye Zaymishche 2,350 meters. During the middle of the summer the water runs along one channel about 800 meters wide.

The Volga is deepest for this sector at Sosykola (more than 35 meters). Below Vyazovka and Vetlyanka it reaches a depth of 24-25 meters. The Volga is shallowest at Peschannyy Yerik. For the rest of its length there is no depth shallower than 2.5-3 meters. From Akhtuba to Petropavlovskaya village the Volga flows all the time through several channels. Rarely, and only during low water-level, does it restrict itself to a single bed.

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2. Volga River

(From the Confluence of the Kama to the Caspian Sea)

(a) Hydrography and Water Regime

General Considerations

The Volga enters the limits of Nizhneye Povolzh'ye from the point of the confluence of its largest tributary, the Kama, 1854 kilometers above its mouth. The basin of the Volga grows rapidly up to the confluence of the Kama. Below the confluence of the Kama the growth of the basin is slow, but it is faster for the right than for the left bank. The area of the Volga basin within the limits of the region under discussion (according to 1:420,000 scale map) is equal to 250,765 square kilometers, or 17.8 percent of its total area of 1,402,010 square kilometers (according to Tillo). The right bank includes 60,495 square kilometers (24 percent), the left bank 190,270 square kilometers (76 percent).

After the confluence of the Kama, the descent of the Volga is gradual without any sharp drops. Distribution of the gradients along the river (Tillo, 2347) is as follows:

Place Names along the Volga	Distance between points (kilometers)	Total Descent	Gradient
Undor	33	0.4	0.000012
Ul'yanovsk	59	2.6	0.000044
Sengiley	94	4.7	0.000050
Stavropol'	81	2.3	0.000028
Samara	122	4.5	0.000037
Syzran'	190	6.0	0.000031

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Place Names along the Volga	Distance between points (kilometers)	Total Descent	Gradient
Confluence of Irgiz River	500	18.8	0.000038
Dubovka			
Mouth of Volga	660	10.8	0.000023

Drawing 2 shows an abbreviated longitudinal profile of the Volga sector from the confluence of the Kama to Astrakhan' according to data of "Byuro Bol'shoy Volgi Giprovoda."

Mean gradients of the Volga for its delta section are given according to the months of the year in the following table (Baledinskiy 276):

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Place Names	Distance between points	Gradients (in millionths) by Months											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Stalingrad	492	30.4	29.9	29.5	30.4	37.3	36.1	30.8	29.7	29.2	29.1	29.0	28.5
Astrakhan'	87	6.8	7.5	5.4	6.5	22.3	30.6	15.1	8.5	6.0	7.1	7.2	4.9
Boasta	10	13.0	9.0	7.0	11.0	18.0	22.0	16.0	14.0	12.0	9.0	13.0	15.0
Biryuch'ya Kosa													
12th Foot Roadstead	67	-	-	3.3	4.9	6.4	6.9	3.9	2.1	2.1	3.1	1.5	-

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Drawing 3 shows an abbreviated longitudinal profile of the delta sector of the Volga along Bakhtemirovskiy Farvater (Bakhtemirov Fairway) according to data from the survey made in 1919-1925 by the Volga Port Survey Party (Baledinskiy, 276).

Volga from the Confluence of the Kama to Syzran'

Below the confluence of the Kama, the Volga flows westward for a distance of 10 kilometers and then sharply turns south. Below Ul'yanovsk it goes southwestward for a short distance, after which it flows south until it meets the Zhigulevskiye Gory (Zhiguli Mountains), which throw it back far to the east. Having gone around the Zhiguli Mountains, it forces its way through the so-called Samarskiye or Zhigulevskiye Vorota (Samara or Zhiguli Gates), after which it flows eastward to Syzran'. The length of the sector from the confluence of the Kama to Syzran' is 506 kilometers.

The Volga valley widens after admitting the Kama, being 21 kilometers wide at the confluence of the Kama with the Volga, and later, between Tetyushi and Ul'yanovsk, at the village of Undor, widening to 29 kilometers. About two kilometers below the village of Korolevka, the left elevated bank draws close to the Volga. Here the bed is only 3½ kilometers wide in spring. Further on, the high mountains of the right bank and the unfloodable elevated and hilly left bank recede, the bottom land widens, and about 10 kilometers below in the direction of the current it widens to 11 kilometers at the traverse of the village of Krasnyy Yar, and as much as 13 kilometers at the traverse of the village of Kremenka. Below at the traverse of Kriushin Island, the elevations of the right and left banks again draw near to the river and the bottom land narrows down to 4 kilometers. Still lower, at the Usul'ye sector, the river has bottom land

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on both sides. Here the main bed has not yet reached a permanent location. At the Zhigulli sector the river bed without deviation follows the mountainous and difficult-to-wash-away right bank, while on the left side it is limited by bottom land 1 to 3 kilometers wide. At the Zhigulli Gates sector, where both the right- and left-bank of the Zhigulli achieve their closest proximity, the bottom land of the left bank achieves a width of 1,070 meters. The full width of the river at the maximum spring flood in 1926 was here 2,320 meters. From the village of Krasnaya Glina to the lower boundary of Samara the Volga does not have a left-side bottom land. Below Samara, there begins a widened left-side bottom land, about 150 kilometers completely devoid of any large secondary channels.

The middle channel (ruslo) of the Volga achieves its greatest width at the sector from Undor to the bend (luka), that is, at the Palitsynskaya Voloshka (Palitsyn Channel), near the confluence of the Kriushinskaya Voloshka (Kriushin Channel), and approximately 5 kilometers below Buyeraki it becomes 1.7 kilometers wide. The channel (ruslo) is widest for the bend (luka) sector above Russkiye Lipyagi - 1.7 kilometers. The prevailing width here is about 1 kilometer; the narrowest is less than 0.5 kilometers near Sheremet'yevo.

The deepest mean depth for the sector from Undor to the bend is 23 meters at Undor. The predominating depth for the fairway varies within the limits of 8.5 to 15 meters, the shallowest depth being 2.3 meters at Akhtushinskiy Pereval (Akhtushin Pass). For the sector of the bend below the village of Pecherskoye the greatest depth is 18.5 meters, and about 17 meters at Stavropol'. The prevailing depths for the bend sector are 6-13 meters, the shallowest 4.3 meters.

For almost the entire length of the Volga, there are to be found, principally along its left bank, a large number of secondary

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channels, backwaters and dried beds. The principal ones up to the bend are: Palitsynskaya Volozhka (Palitsyn Channel), Krasnoyarsk, Gorodishche, Kriushin Backwater, Svinukha Volozhka (Svinukha Channel), Podval'skiy Backwater, Sukhaya Atruba Channel, Krivolushskiy and Goryachiy Backwaters. For the sector of the bend there are to be noted Gerryy Channel, Rozhdestvenskaya Volozhka (Rozhdestvenskaya Channel), Podzhabinskiy Backwater and Yekaterinovskaya Volozhka (Yekaterinovskaya Channel).

Two kilometers below Chkyuli Gates the bed of the Volga is divided into two channels by the bottom land, forming Gerryy Island. For the past 40-50 years the right Gerryy Channel, being considerably silted with sand, has been playing a secondary role. During the past ten years there has gradually appeared a wide left bank (pobochen') and at the same time there has been intensified the washing out of the right Gerryy Channel, which, after the flood of 1926, became the principal channel.

Somewhat further down at Barbashina Polyana there begins one of the principal channels, Rozhdestvenskaya Volozhka, which, in relation to the main channel, shortens by approximately 20 percent the route for the flow-off of high waters. The Samara Channel (Samarskiy Protok), newly formed within the past few decades, flows into the middle part of Rozhdestvenskaya Volozhka. The Volga threatens to divert its course into Rozhdestvenskaya Volozhka, inasmuch as the flow of water becomes stronger through it each year. The distance between the beginning and outlet of Rozhdestvenskaya Volozhka is 10 kilometers, while along the main channel it is 15 kilometers. Filling in (zanosimost') of the shore line at Samara is directly related to the Rozhdestvenskaya Channel which from year to year grows wider and deeper.

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The overflow of waters from the main channel into bottom land through the high flood channels is to be considered as an adverse manifestation. (The high flood channels are located opposite the Samara Roadstead.) As a result of the transfer of the fairway opposite Samara to the right bottom land shore there has resulted a considerable washing away of this shore, and the width of the main channel of the Volga near the city below Rozhdestvenskiy Channel (protok) increases each year, while at the same time its depth is gradually growing more shallow.

The distribution of the discharge of spring waters in the main channel of the Volga and in the right bottom land with its channels can be seen from the following table compiled from 1926 data of the Engineer Hydrologic Station of the People's Commissariat for Railroads:

Level in Meters	Discharge in Cubic Meters per Second	Distribution of Discharge in Percent In front of Postnikovskiy Ravine		Below Samara Channel of Rozhdestvenskaya Volozhka	
		Main Channel	Bottom land with Channels	Main Channel	Bottom land with Channels
15.63	60877	91.7	8.3	83.9	16.1
12.76	33203	89.1	10.9	78.1	21.9
11.26	25985	91.5	8.5	78.5	21.5
2.83	5078	100	-	90.6	9.4

The maximum flow-off of water into the bottom land through the Samara Channel accounts for a drop of 12.76 meters in the water level. With higher and lower water levels the amount of flow-off decreases. For average mean water levels, almost the entire flow-off is done through Samara Channel.

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Volga from Syzran' to Akhtuba

For the sector from Syzran' to Akhtuba Channel, 764 kilometers in length, the Volga holds to a southwesterly direction and flows past a wide bottom land, holding to the right bank, and approaching the left side of the valley only at Marksshtadt and Engel's (formerly Pokrovsk), Novnoye, and Bykovyye Khutora. The width of the river at Marksshtadt during the flow of spring waters is less than 2 kilometers. During summertime the water is contained in one channel whose width is about 1.8 kilometers. Further down the bottom land widens, reaching 15 kilometers at Chardym. Further on towards Saratov it narrows down to 5 kilometers. Below Saratov at Uvek the Volga waters recombine to flow along one bed.

The width of the middle channel varies throughout its entire length from 0.5 to 2.2 kilometers. Its greatest mean depth along the sector from Syzran' to Akhtuba is to be found at Khvalynsk and the confluence of the Malyy Irgiz, where it reaches 22-22.5 meters. Above Volotovskiy Backwater the depth becomes 20 meters. In other places the depth for stretches varies between 8 and 15 meters. Its shallowest depths are along the sand shoals, of which there are 46 between Syzran' and Akhtuba at the Vol'sk-Saratov sector. Here, between the confluence of Chardym and the confluence of Tul'skaya Volozhka (Tul'skaya Channel), the Volga has an average mean depth of 1.8 meters. Opposite Tayurikh, below the confluence of Vol'shoy Karaman River and at the beginning of Tul'skaya Channel, the depth along the fairway is about 2.5-3 meters. In other sectors the depth exceeds 3 meters.

Throughout the entire distance from Marksshtadt to Akhtuba the bottom land of the Volga is broken up by the various channels (protoki, volozhki) into islands, some of which make up clusters.

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The length of individual islands can be as long as 10 kilometers. The principal channels to be found here are: Devichnaya above Vol'sk (right bank), Tul'skaya at Yel'shanka, Vorovskaya (left bank) at Podstepnaya Colony, Tarkhanka at Saratov, where there are also Pokrovskiy and Saratov backwaters, Karavainskya at Bykovyye Khutora, Balykleyskiy at Balykley, Olenineskaya at Oleni, Pogromenskaya at Dubovka and the beginning of Akhtuba Channel at Chernyy Bynok, 631 kilometers from the mouth of the Volga.

The channels of the Volga, having uneven velocities where they cross and meet, throw off silt which form shoals, which are sometimes large and which present a hazard for shipping. It is interesting to note that Tarkhanka, a channel of the Volga at Saratov, was once the principal bed, but at the present time is a channel with an insignificant flow of water. The silt deposits in the Tarkhanka from Pokrovskiy Channel, which has a faster current than Tarkhanka, make it difficult to approach Saratov through it.

The Volga from the Beginning of the Akhtuba to the Beginning of the Buzan

After the branching off of the Akhtuba, the Volga preserves its initial southwesterly direction up to Krasnoarmeysk (formerly Sarepta). Further on the Volga turns southeastward and flows along this direction to the villages of Petropavlovskaya and Lebyazh'ye, below which is generally considered to be the beginning of the Volga delta.

This sector is characterized by a total absence of tributaries (with the exception of small drying streams) and a wide river valley. Its width at Krasnoarmeysk reaches 32 kilometers, narrowing down to 16 kilometers at Kamennyy Yar and 19 kilometers at Chernyy

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Yar. Above Vetlyanskaya village the width of the valley is 9.5 kilometers. Then the valley widens, and, 11 kilometers below Yenotayevsk, it becomes 30 kilometers wide, while after the beginning of the delta it widens to more than 50 kilometers. The width of the main channel varies: at Stalingrad it is 2,000 meters, at Krasnoarmeysk 450 meters, below Solenoye Zaymishche 2,350 meters. During the middle of the summer the water runs along one channel about 800 meters wide.

The Volga is deepest for this sector at Sozykola (more than 35 meters). Below Vyazovka and Vetlyanka it reaches a depth of 24-25 meters. The Volga is shallowest at Peschannyy Yerik. For the rest of its length there is no depth shallower than 2.5-3 meters. From Akhtuba to Petropavlovskaya village the Volga flows all the time through several channels. Rarely, and only during low water-level, does it restrict itself to a single bed.

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The profile referred to precedes p. 159 of original.

Drawing 3. Longitudinal Profile of the Delta Sector of the Volga along Bakhtemirovskiy Channel from Astrakhan' to 152.5 kilometers according to data obtained during 1919-1925 from a survey by the Volga Port Survey Party.

[Note: The numbers given here are shown in ink on photostat of original, opposite place name or other designation.]

1. Bench marks for maximum level
2. Bench marks for minimum level
3. Bench marks for mean level for August, September, October and November 1918-1925.
4. Relative depth of the bottom with respect to the surface level.
5. Distance from the mouth in kilometers.
6. Datum marks.
7. Kilometers.
8. Tizan' River
9. Darma River
10. Volga River
11. Chilimnaya River
12. Bertyul' River
13. Lagoza River
14. Chilimnaya River
15. Astrakhan'
16. Semirublevoye
17. Aleksandrovskiy Landing
18. Chetrye/Khbugornyy Lighthouse
19. Benchmark
20. Benchmark
21. Benchmark
22. Profile compiled on the basis of relative readings compiled by the Volga Descriptive Party. Add 7.45 meters to transform to absolute readings.

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The profile referred to is opposite p. 156 of original.

Drawing 2. Longitudinal Profile of the Volga from the Confluence of Kama River to Astrakhan'.

[Note: The numbers given here are shown in ink on photostat of original opposite place name or other designation.]

1. Absolute elevation of the maximum level during the flood of 1926.
2. Average mean level, 1906.
3. Absolute elevation of the bottom along the fairway.
4. Distance from the mouth.
5. Confluence of Kama R.
6. " " Sheshma R.
7. " " Ireyevskaya Volozhka
8. " " Ayma R.
9. " " Cheremshan R.
10. " " Usa R.
11. " " Sok R.
12. " " Samara R.
13. Beginning of Yekaterinovskaya Volozhka
14. Confluence of Yekaterinovskaya Volozhka
15. " " Syzranskaya Volozhka
16. " " Chagra R.
17. " " Malyy Irgiz R.
18. " " Balakovka R.
19. " " Torsa R.
20. " " Bol'shoy Irgiz R.
21. " " Karaman R.
22. " " Tereshka R.
23. " " Chardym R.
23a. Beginning of Tarkhanskaya Volozhka
24. Confluence of " "
25. " " Kriusha R.

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26. Confluence of Tarlyk R.
27. Kayyarovakha
28. Confluence of Yeruslan R.
29. Beginning of Karavayevskaya Volozhka
30. " " Pogromaya Volozhka
31. " " Akhtuba R.
32. Confluence of Dumovskaya R.
33. Beginning of Solodovikovaya Volozhka
34. Confluence of " "
35. Beginning of Vyazovka Volozhka
36. Confluence of " "
37. Beginning of Vladimirovka Volozhka
38. Confluence of " "
39. Beginning of Trekhovskaya Volozhka
40. Confluence of " "
41. Beginning of Bober Volozhka
42. Confluence of " "
43. " " Yekaterinovskaya Volozhka
44. " " Yenotayevka R.
45. " " Kizinka R.
46. Beginning of Buzan Kutuk (Channel)
47. " " Durnovskaya Volozhka
48. Confluence of " "
49. Snasskiy Backwater
50. Tetyushi
51. Zakharov Mine
52. Ul'yanovsk
53. Krasnoyarskiy Backwater
54. Singeley
55. Pedval'skiy Backwater
56. Novodivich'ye

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57. Stavropol'
58. Gorkvashi
59. Barbashina Polyana
60. Samara
61. Podzhabinskiy Backwater
62. Perevoloki
63. Syzran'
64. Rutratskiy Backwater
65. Backwater
66. Aleksandrovskiy Backwater
67. Vol'sk
68. Saratov
69. Uvekskiy Backwater
70. Zolotaivskiy Backwater
71. Kamyshin
72. Solyanoy Backwater
73. Stalingrad
74. Tsaritsinskiy Backwater
75. Krasnoarmeysk
76. Yakshin Backwater
77. Volavitskoy Backwater
78. Khokhlatskiy Backwater
79. Chornyy Yar
80. Yenotayevsk
81. Kapitanskiy Backwater
82. Astrakhan'
83. The profile was composed in absolute elevations according to data of the Greater Volga Bureau.

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The winter flow is computed from the summer curve, with the introduction of a coefficient of K = 0,60, as at Stalingrad. Originally the coefficient used was 0.50, but a comparison of results received in Samara, Saratov, and Stalingrad, showed a disparity between the flow at these three points. Therefore the winter flow was converted at K = 0.60 (coefficient received for Stalingrad). The flow at Saratov has been computed since 1881.

At Stalingrad water measurements have been carried out since 1876. Until 1881 we have no information regarding the period of freezing over the river. However, for the Stalingrad post a curve was drawn up of the dependence of the water discharge on the levels of the discharge measured at the Dubovka hydrometric station located 50 kilometers from Stalingrad. Discharges at Dubovka were measured by Volga descriptive parties, during the period 1884-87, and, by the Kazan' Okrug PS in 1912-15 (Sokolov, 1931). In 1884-87 the measuring was done at the hydrometric station, but in 1912-15 on two sectors: Pichushinskiy, located above the station, and Porromenskiy (below).

0 on the graph = 18.76 meters
The initial datum point mark on the right pier of the observation post, its absolute mark 20.35 meters.

Figure 15. Graph of the Volga water level at the Syzran' bridge.

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0 on the graph = 9.42 meters. The initial datum point (upper iron pole on the right bank), its absolute mark 25.00 meters.

Figure 16. Graph of the Volga water level at Vol'sk.

Figure 17. Graph of the Volga water level for duration of the navigation period at Vol'sk.

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0 on the graph = 5.00 meters. The initial iron-concrete datum point on the right bank, its absolute mark 23.0 meters.

Figure 18. Graph of the variation in the Volga water level at Saratov.

Figure 19. Graph of the Volga water level for the duration of the navigable period at Saratov.

The curve of discharges at Stalingrad, measured at Dubovka, is related to the level which is observed at the Stalingrad post at 7 AM the day following the measuring. In this, we take the discharge of the Volga itself plus the discharge of active currents, which we determine by a curve of discharges specially drawn up for them. The currents begin to

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work at a level of 2.53, 0 on the graph. The curve is drawn up according to centers of gravity, which are computed as the arithmetic averages of groups of discharges and levels. The curve was extrapolated on the graph below to a level of 1.70 meters above the graph's zero and above to a level of 10.00 meters. The curve covers the period since 1881, since up till then we have no information on freeze-overs. The winter discharges were determined from the summer curve using a conversion coefficient of 0.60, which was inferred on the basis of 15 frozen winter discharges. The variations in the discharges for the period of ice-flow was obtained by the hydrographer by means of joining smoothly the winter and summer sections.

Discharges measured in the Volga delta, published in the works of N. N. Sokolov, cannot be utilized for determining the flow, since the wind outflow (sgon) to and inflow (nagon) from the sea greatly distorts the natural variations in the level.

Cubic Meters per second

Figure 20. Graph of typical discharges of the Volga at Samara for 1877-1929.

First in accuracy of computations of flow we ought to put the Volga at Tetyushi, where discharges have been most reliably determined; second, the Volga at Stalingrad, which, though reliable discharges have been to a sufficient degree determined, because of a certain instability of the river bed and conditionality in the transmission of discharges, may give certain inaccuracies; and last, the Volga at Samara, and especially at Saratov, where the measurement of discharges was weakest.

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Character of the flow

The average flow of the Volga is at Tetyushi (for 26 years) 245.2 cubic kilometers, at Saratov for 46 years 263.3 cubic kilometers, and at Stalingrad for 47 years 260.2 kilometers. The yearly flow of the Volga in 1902, 1912, 1918, 1924, 1932, 1938, and 1948 was close to the average for all points. The maximum flow occurred in 1926, with 1.24, 1.27, 1.29, and 1.15 close to it. The minimum flow was in 1921, with 1.10, 1.01, and 1.30 close to it.

The flow of the Volga in different years shows a sharp variation which illustrates the relation of flows of years with different water supply. The relation of the maximum volume of yearly flow to the minimum is 2.90 for Tetyushi, 2.56 for Samara, 2.40 for Saratov, and 2.33 for Stalingrad. The relation of the flow of the maximum year, 1926, to the flow of an average year, 1908, is 1.62 for Tetyushi, 1.57 for Samara, 1.50 for Saratov, 1.50 for Stalingrad. Finally, the relation of the flow of the minimum year, 1921, to the flow in 1908 is 0.55 for Tetyushi, 0.61 for Samara, 0.62 for Saratov, and 0.65 for Stalingrad. The flow is very unequally distributed for different parts of the year. On the average, the flow for April, May, June, and July is around 65-70 percent of the yearly flow and the remaining 8 months only 30-35 percent.

For the characteristics of the yearly distribution of the flow, we include a graph of the typical variation of the Volga flows at Samara (Lopatin, 518). The graph (figure 20) is drawn up by the method of B. G. Glushkov. The observation period is 1877-1929. Depending on the number of floods in the summer period, we have 2 types of graphs: the first, one flood in the summer period; the second, for two floods. The distribution of the yearly flow by seasons in Samara is shown on the following table, computed from the typical graph.

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		Season			
Flow	Type	Winter	Spring	Summer	Autumn
In cubic kilometers					
In percent of the yearly flow					

Increases in the natural flow result from melting spring snow, from the spring-autumn rains, and from the ground supply. These high points on the typical graph for Samara are:

		Origin of the Flow			
Flow	Type	Melting of Snow	Spring-autumn Rains	Ground Supply	Total
In cubic kilometers					
In percent of the yearly flow					

The least subsurface flow (ground supply) was determined by a hydrographer to be for the year 1921, a year of little water, 56.4 cubic kilometers or 36.7 percent of the whole yearly flow, and for 1921, 53.6 cubic kilometers, or 35.6 percent of the yearly flow.

Character of discharges and the level

Below the Kama the Volga has no important tributaries, and rivers falling into its lower part are in most cases dry. Thus, having basically a unique supply from its basin, which is located above the Kama mouth, the Lower Volga is characterized by a unique yearly course of discharges and levels for all points not subject to the action of winds. In the Volga delta a certain distortion may also be observed (in addition to

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the distortion from water flowing in from the sea) from the widening of river valleys and channels, an action which is in part determined by a high water level.

0 on the graph = 11.93 meters. The initial iron-concrete datum point, 1/13, on the right bank, has an absolute mark 8.29 meters.

Figure 21. Graph of the variation of the Volga water level at Kuybyshin.

Figure 22. Graph of the Volga water level for the duration of the navigable period at Kuybyshin.

0 on the graph = 11.39 meters. The vertical datum point (upper iron pole of the observation point, 191h, on the right bank), has an absolute mark 2.20 meters.

Figure 23. Graph of the variation of the Volga water level for Stalingrad.

Figure 24. Graph of the Volga water level for the duration of the navigable period at Stalingrad.

0 on the graph = 22.12 meters. The initial datum point on the vertical face of the post (iron post, 191h, on the right bank),

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its relative mark 3.65 meters.

Figure 25. Graph of the variation of the Volga water level at Chernyy Yar.

Figure 26. Graph of the Volga water level for the duration of the navigable period at Chernyy Yar.

The change in the level and discharge of the Volga at the mouth of the Kama is reflected in a certain retardation in all its lower localities, except for the delta, where, because of the influence of winds, with and against the current only the spring floods are felt, and other floods disappear with the rise and fall of the water due to the action of with- and contra-current winds. This character of the Volga water level gives the possibility of establishing a linear dependence between levels at its different points, particularly in order to verify the registers received at the Volga observation posts. Thus it was found that the discrepancy in determining levels at Stalingrad according to levels at Samara was on the order of 10-15 centimeters.

In Tetyushi the following yearly course of the Volga water level was observed. In the beginning of April (the average for 53 years is April 5) the spring rise of water begins, reaching a maximum in the middle of May. The maximum level is usually maintained for several days, after which the fall begins (average and extreme dates are given on the standard graph, Figure 5). The average elevation of the water rise is more 11 meters. The duration of the rise is on the average 41 days, which gives an average rise of 0.27 meters per day. The maximum daily rise of water is more than 1.00 meters, and in individual years a rise of as

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much as 1.4-1.7 meters per day is seen. The fall of the water is less intensive than the rise (on the average, 0.23 meters per day, and in individual years a maximum of 1.2-1.3 meters per day).

For other observation posts, the spring floods have about the same character, with certain retardation, whereupon for lower observation points a certain spreading out of the flood may be seen. Thus, for Astrakhan' the duration of the spring floods already reaches 103 days, in contrast to 82 at Tetyushi.

Sector	Length in kilometers	Average rapidity of the spreading of the flood, meters per second	Days of movement of flood (according to Karelina)	Time of expansion of flood (according to a typical graph)
Confluence of the Kama-Tetyushi				
Tetyushi-Samara				
Samara-Vol'sk				
Vol'sk-Saratov				
Saratov-Kamyshin				
Kamyshin-Stalingrad				
Stalingrad-Astrakhan'				

It takes the flood 20-30 days to move from the confluence of the Kama to Astrakhan'; at the fastest, 23 days. At Astrakhan' the influence of winds on the Volga level is not felt at the time of high spring flood levels. The highest point of the spring floods on the average is at Tetyushi 11.0 meters, at Samara 10.6 meters, at Vol'sk 9.5 meters, at Saratov

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10.3 meters, at Stalingrad 8 meters, and at Astrakhan' 3.2 meters above the lowest point before the rise. The maximum height above 0 on the graph was in 1926: at Tetyushi 15.40 meters, at Samara 14.71 meters, at Vol'sk 14.76, at Saratov 13.78, at Stalingrad and at Astrakhan' 4.22 meters. And, finally, with the low spring floods in 1924: at Tetyushi 15.40 meters, at Samara 8.45 meters, at Vol'sk 8.23, at Saratov 7.02, at Stalingrad 6.41, and at Astrakhan' 2.35 meters. Years with high spring floods were 1926, 1919, 1929, 1927, 1917, 1895, and 1914; the year with the highest was 1926. Years with low spring floods were 1891, 1921, 1890, and 1930; the lowest spring flood was in 1891.

0 on the graph = 31.85 meters. The initial datum point on the vertical face of the post (iron pole of the observation post on the right bank), its conditional mark 20.48 meters.

Figure 27. Graph of the variation of the Volga water level at Yenotayevsk.

Meters

Days

Figure 28. Graph of the Volga water level for the duration of the navigable period at Yenotayevsk.

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0 on the graph = 32.26 meters on the vertical face of the post. The initial datum point, 1912, on the left bank, its relative reading 27.44 meters on the vertical face of the post.

Figure 29. Graph of the variation of Volga water level at Astrakhan'.

Meters

Days

Figure 30. Graph of the Volga water level for the duration of the navigable period at Astrakhan'.

Points according to Tsinlevskiy, 1904

Points at the village Olya, 3 March to 8 October 1921

0 mark on the scale of the graph 32.41 on the vertical face of the post

Decrease in level / Increase in level — Centimeters

Projection of the force and direction of the winds blowing against the stream to the northwest, in meters per day.

Projection of the force and direction of the winds blowing with the stream to the southeast, in meters per day.

Figure 31. Graph of the dependence of the Volga water level at Boast Island on the force and direction of the wind.

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Cubic meters per second

in thousands

Days

Figure 32. Graph of the duration of discharges of Volga water at Samara.

Years with a high spring flood are not always for the Volga years with maximum flow. Thus, for example, 1917, a year of high spring flood -- at Saratov 12.27 meters above 0 of the graph -- had a low average water level, with the lowest 0.17 meters above the same zero. The converse is seen in years with low spring flood. But spring floods are usually to a considerable degree determined by the amount of yearly flow.

The summer period for the Volga is characterized by the presence of several floods caused by summer rains. The first flood usually begins before discharges and levels following the spring floods become again average. Of all the summer floods, which in individual years may number 6 or more, three are most characteristic, with the probability of their appearance no less than 30 percent.

The appearance of these 3 floods in one season is not characteristic for the Lower Volga. Also the case of all three floods being absent is not characteristic -- this occurs primarily in years of little water.

As the number of floodless years increase, cases of the appearance of the first and third floods at Stalingrad in comparison with Saratov lessen -- this can be explained by the fact that small floods still observed at Saratov spread and flatten out by the time they reach Stalingrad, due to the branching off of the Akhtuba River as well as because of the widening of the river bed itself.

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The height of individual summer floods reaches 3 meters above the mean water level at Tetyushi, 3 meters at Saratov, and 2 meters at Stalingrad (by average water level is understood low levels in the period between two flood periods). October-November for Tetyushi and November-December for the lower Volga are characterized by a rise in water due to the fall rains. On the average the height above the mean water level is 1.9 meters at Tetyushi (2.4 meters above 0 on the graph), at Saratov 1.8 meters (around 2 meters above 0 on the graph), and at Stalingrad 1.3 meters (2.1 meters above 0 on the graph). In years of a high fall water level, the height was reached in Tetyushi 6.6 meters above zero on the graph, and in Stalingrad 5.2 meters. Before the beginning of the winter freeze-over (at the time when ice masses float on the river) are usually seen the lowest levels in the year -- which then rise and in January reach their maximum for the winter period. Levels fall then, and before the beginning of the spring ice break-ups a second minimum is reached, which is characterized by low water discharges for the river.

Levels at the Volga delta have their own special character. The variation in levels, which is linked to the character of discharges, is at a maximum at the beginning of the delta, and gradually dies out in approaching the sea. The converse is seen in the variation in levels due to winds with and against the current. The maximum variations occur at the sea-shore, gradually dying out in the upper part of the delta. The length of the waves of the spring floods is on the average 7.13 meters for Stalingrad, 2.93 meters for Astrakhan', and 0.38 meters for Bogat Island. The rising period of the spring waves is shorter than the falling period.

The sea level is subject to considerable variations, especially in shallow places, under wind action, which is affected by the configura-

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tion of the shore, and the direction, force, duration, and angle of inclination of the wind to the sea surface. We may consider, as an approximation, that winds blowing in a northeast-southeast direction are with the current, and northwest-southwest against the current. The line north-northeast to south-southwest may be considered neutral. Low ring in the normal level induced by winds against the current reaches at the Biryuchiya Kosa as much as 0.64 meters. The rise in level due to winds with the current reaches 2.36 meters at the Biryuchiya Kosa. The rapidity of the fall of water with winds towards the sea is 8.7 centimeters per hour, while its rise with winds against the current is 7.5 centimeters per hour. At Boast Island this phenomenon occurs less rarely, and the fall here is up to 3 centimeters per hour (12 September 1921), but the rise is up to 6 centimeters per hour (13 September 1921).

A sea wave coming in against the current radiates far into the Volga delta; essentially it creates a rise in the river water with a certain penetration of sea water in the river. These changes are proportional to the projection of winds in a west-northwest to east-northeast direction, to the speed of the wind and its duration. Winds perpendicular to the neutral line, t.e., having a west-northwest to east-northeast direction, induce the greatest changes in level. The graph (Figure 31) worked out by Tsishevskiy (Valendinskiy, 276) shows the dependence of the height of water on the force and direction of the wind at Boast Island. The relation between the height of waves coming in against the current at Boast Island and at Astrakhan' (Tsishevskiy, 455) is seen on the following table:

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Difference of level at Astrakhan' and at Seast Island in meters . . . . . .

Height of waves against the current in percentage of height of waves at Seast Island . . . . . .

Characteristic discharges

The yearly course of Volga discharges usually follows the variations in the water level so that the maximum discharge is seen several days before the highest level. However, in view of the fact that curves of water discharges (except the one for Tetyushi) were drawn up generally for the rise and fall, this correspondence is not seen on our hydrographs. Discharges of water on the Volga vary greatly, as is evident from the table appended below, in which relations between characteristic discharges are established. The characteristics are given for the average of characteristic discharges for the whole period of observation, and for typical years they are: 1926, largest flow and in height of spring flood; 1921, having the least flow, minimal spring floods and minimal average water level; 1909 and 1924, average years, of which the first is nearest to the average in flow (for Samara), but the variations in discharges through the year are not entirely characteristic. The second, 1924, has yearly variations in discharges which are very close to the variations of discharges on a typical graph in height of floods and average water level as well as in their duration, although the difference in time of arrival of the spring floods is 5-10 days (see table on page 183).

It is easy to notice that towards the mouth a regular effect on

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the Volga discharges is felt in the narrowing of the river valley at the Samara Gates, the Cyaran' bridge, Marksshtadt, and Uvek. This phenomenon is particularly noticeable in comparison with characteristic discharges along the length of the river. Maximum discharges from Tetyushi decrease to the mouth. The peak of the flood, decreasing in height, becomes wider. Thus the maximum discharge of 1926 (this is the largest discharge for the entire period of observation) was at Tetyushi 67,000 cubic meters per second, at Samara 67,000 cubic meters per second, at Saratov 56,400 cubic meters per second, and at Stalingrad 46,450 cubic meters per second. The average of the minimum for the entire period of observation was: at Tetyushi, 37,140 cubic meters per second, at Samara 34,740 cubic meters per second, at Saratov 35,190 cubic meters per second, and at Stalingrad 34,490 cubic meters per second, and, finally, the lowest of the maximum yearly discharges was observed in 1891 -- at Tetyushi 16,030 cubic meters per second, at Samara 16,350 cubic meters per second, at Saratov 15,660 cubic meters per second, and at Stalingrad 16,900 cubic meters per second. The maximum discharge at Stalingrad in percentages of the discharge at Tetyushi was: in 1926, 71 percent; for the average of many years of maximum discharges, 91 percent; and for 1891, 129 percent. Thus even with average spring floods the regular effect of the rise is felt in places where there is a narrowing. In addition to the narrowing, the spreading out of the water over the vegetation of its bottom lands also strongly influences discharges. Minimum discharges from Tetyushi to the mouth are considerably increased. The arithmetical mean of the yearly minimum summer discharges is: for Tetyushi, 3,490 cubic meters per second; for Samara, 3,540 cubic meters per second; for Saratov, 4,130 cubic meters per second; and for Stalingrad, 3,700 cubic meters per second. This gives an absolute increase over the average of the minimum yearly discharges

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at Stalingrad of 310 cubic meters per second in comparison with Tetyushi (6 percent of the discharge of the Volga at Stalingrad). This indicates a considerable ground supply for the Volga in this sector, since the supply received by it from a few rivers which do not dry up in the summer period is insignificant in comparison with the discharge of the Volga itself. For individual years however, an increase in the minimum discharge towards the mouth is not observed, which can explain the insufficient accuracy obtained in computing discharges. The Volga bed to one degree or another is subject to changes, sometimes on a considerable scale, which is very evident when one combines curves of discharges for various years for one point or compares curves of the levels of certain Volga observation posts for various years. This change is not identical for one year at various observation points, but one curve of discharge is drawn up for the whole observation period. The least of the minimum yearly discharges was seen at Tetyushi in 1912 -- 2,250 cubic meters per second, at Samara in 1921 -- 2,060 cubic meters per second, at Saratov in 1912 -- 2,660 cubic meters per second, and at Stalingrad in 1912 -- 1,550 cubic meters per second.

Year	Q Annual Mean	Q Maximum Summer Minimum	Q Maximum Winter Minimum	Q Mean Summer Minimum	Q Mean Winter Minimum	Q Mean Oct - March Q Annual Mean	Q Mean Apr - Dec Q Annual Mean	Q Mean July - Nov Q Annual Mean
Tetyushi								
Multi-annual mean								
Samara								
Multi-annual mean								

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Saratov

Multi-annual mean

Stalingrad

Multi-annual mean

The relation of Q maximal maximum to Q minimal minimum for the period of observation is 44.0 for Tetyushi, 32.5 for Samara, 29.4 for Saratov, 34.6 for Stalingrad.

The duration of the lowest summer discharges differs in different years. For summers when many summer rains fall in the Volga basin, (low warm daily level) discharges are held several days, but sometimes discharges begin to increase without reaching the mean multi-annual daily level. In dry years, such as 1921, 1891, and 1910, prolonged low levels and low discharges are observed, and during the 3 summer months there are no floods.

Cubic meters per day

Figure 33. Graph of the variation of discharges for the Volga at Tetyushi.

Cubic meters per second in thousands

Days

Figure 34. Graph of the duration of Volga discharges at Tetyushi

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Cubic meters per second, in thousands

Figure 35. Graph of the variation of discharges for the Volga at Saratov.

The minimum winter discharges, although computed approximately, have on the average the same character of changing towards the south as summer discharges. The average of the minimum winter discharges is 2,2h0 cubic meters per second at Tetyushi, 2,2h0 cubic meters per second at Samara, 2,200 cubic meters per second at Saratov, and 2,h10 cubic meters per second at Stalingrad, which gives an increase of 20 percent at Stalingrad in comparison with Tetyushi.

Cubic meters per second, in thousands

Days

Figure 36. Graph of the duration of Volga discharges at Saratov.

Here it is necessary to notice that on the tables of characteristic discharges (page 169) the least winter levels before the beginning of the spring ice flow are given, although often enough they are not the least computed for the winter of a given year, which is evidently worthwhile because of the inexactitude of determining the transitional coefficient "K."

Cubic meters per second, in thousands

Figure 37. Graph of the variation of discharges for the Volga at Stalingrad.

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The average Volga discharge for the whole period of observation is 7,770 cubic meters per second for Tetyushi, 7,630 cubic meters per second for Samara, 8,750 cubic meters per second for Saratov, and 8,540 cubic meters per second for Stalingrad. These discharges were given for various periods of observation: the least, at Tetyushi -- 26 years (1901-1929), and the most, at Samara -- 53 years (1877-1929). The relation of the average discharge of the Volga at Samara for the whole observation period to the average discharge for the period 1902-1929 is 0.95. Taking this coefficient for other points, the following average multi-annual discharge is obtained.

Observation Point	Period	Mean Q, in cubic meters per second	Period	Mean Q, in cubic meters per second	Multi-annual Q, in cubic meters per second
Tetyushi					
Samara					
Saratov					
Stalingrad					

Thus, we see a rather important increase in the mean discharge along the length of the river towards the mouth. Such a uniform increase is seen for all years, of which in individual years this increase of the discharge at Stalingrad compared with that at Tetyushi is 22 percent of the Stalingrad discharge.

Erosive activity of the Volga

Flowing in a meridional direction, from North to South, the Volga, in accordance with Ber's law, presses on the right bank and erodes it,

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carrying the eroded fragments to the other bank or down the river, and establishing its bed, towards the right bank. This explains sometimes the circumstance that towns on the right bank of the Volga are immediately on the river, but towns on the left bank (except for Engel's) stand far from the river. The undermining of the right bank in not infrequent cases causes cave-ins, when whole streets of the town are lost, as happened for example, in Kamyshin. The movement of the Volga towards its right bank may be followed in these examples: below Astrakhan' in the 16th century, the furthest eastern channel of the Volga-Bold was navigable; in the 17th century the more western Ivanchuk channel; at the beginning of the 18th century the Yarkovskoye channel; at present, the Bakhtiar tributary, which is further west. The movement of the Volga towards the west explains also the wideness of its valley, which is in places more than 30 kilometers wide.

In the Samarskaya Luka section, the main channel of the Volga is naturally disposed to very substantial changes in depth, width, and area of its cross-section, which is to be observed not only in a perspective of many years, but also over this or that year, several months, and even weeks. In times of high waters, alluviation occurs, in times of low waters, erosion.

Cubic meters per second

Days

Figure 38. Graph of the duration of Volga discharges at Stalingrad.

Somewhat above Samara is located in the main bed on the left side the sandbank of Annaevskiy Pobochen', which was still not long ago, in

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1923, a huge mass of alluvia, as much as 13 meters high above the lowest water level, quite slowly shifting underneath according to the river's flow, and almost not changing its size. We have comparatively detailed information concerning its location and size beginning from 1889, from which we may conclude that Annenevskiy Pebochen', undergoing certain comparatively small variations in its size, has moved continually downstream along the left bank, averaging around 125-130 meters per year. In the course of last several years it has ceased greatly and under the action of spring waters extraordinarily low; owing to this it has entered at present the part of the bank at the town, now having a height of 9.5 meters on the average above the lowest water level of the river.

The general course of muddiness of the Volga water during a year may be characterized as follows. The greatest muddiness is seen with the rise of the flood in the period of melting of the spring covering. Then with the fall of the flood muddiness lessens, reaching a stable average water level. In certain periods of average water level, an increase in muddiness is seen, due to the wind's stirring up particles which have settled. After the peak of the flood, the saturation of large particles is not especially great; the upper reaches are characterized by little muddiness (above the mouth of the Oka). Muddiness increases below, and at Samara muddiness of 155 grams per cubic meter has been measured.

The most important material on the flow of water-held matter was obtained by the Hydrometric Station TsNIVT at the Barbashnaya Barbashina Polyana (13 kilometers above Samara). At this point the yearly flow of water-held alluvia (not considering drawn-in alluvia) is 16,942 × 10 cubic meters, which is distributed seasonally in this manner:

Winter -- 259,000 cubic meters, or 1.5 percent; spring -- 14,784,000

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cubic meters, or 87.3 percent; summer -- 1,210,000 cubic meters, or 7.1 percent; and fall -- 669,000 cubic meters, or 4.1 percent (Lopatin, rkp, 1931).

For Lebyazhina Polyana we have the following average distribution of alluvia, in fractions (Polyakov, rkp, 1933). Research in September and October 1930 shows less than 0.01 millimeters is 40 percent; 0.01-0.05 millimeters 10 percent; 0.05-0.20 millimeters 30 percent; 0.20-0.50 millimeters 18 percent; and more than 0.50 millimeters 2 percent. Research in May and June 1931 shows less than 0.01 millimeters were not determined, 0.01-0.05 millimeters 40 percent, 0.05-0.25 millimeters 50 percent, more than 25 millimeters 10 percent.

The movement of Don alluvia was studied by the Lower Volga Project at Saratov in 1932 (Polyakov , 1933). The discharge of Don alluvia was determined for the Verkhne-Lokteinshevskiy shoal for September 9 as 4.2 kilograms per day, and for the sandbank downstream from the first Saratov channel for September 9, 2.3 kilograms per day, which with the discharge of 3,000 cubic meters per second gives for the share of Don alluvia in the general flow of Volga alluvia 2.8 percent of the average water level for the Verkhne-Lokteinshevskiy shoal and 1.6 percent of the average water level for the shoal below the first Saratov channel. In this, the basic mass of drawn alluvia is 0.01-0.05 millimeters in size (95 percent for the shoal below the first Saratov channel, and 90 percent for the Verkhne-Lokteinshevskiy shoal).

In the Volga delta an investigation of the character of alluvia was carried out in 1925, at the time of the research on improving the delta's navigation conditions (Valedinskiy, 27).

According to observations in 1925, the discharge of Volga alluvia for the year at the Novo-Aleksandrovskiy Poselok (village) formed 1,034,100 cubic meters, with the yearly flow for the main bed 102.75

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cubic kilometers -- which gives for the average year, with a yearly flow of 109.8 cubic kilometers, a yearly discharge of alluvia for this point of 1,100,000 cubic meters. Hence the average yearly muddiness of the water is here 43 milligrams per liter.

The yearly growth of the Volga Delta varies from 0.295 square kilometers to 0.042 square kilometers, which gives a linear increase in the delta for various points (in the direction of the Caspian Sea) of 0.72-0.047 kilometers.

Below is appended the distribution of alluvial deposits and muddiness of the three most important waterways of the Volga Delta in 1935 for their most characteristic sections.

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Channel	Year			11 May - 10 August			Average water level (Sept - Nov)			Winter (Dec - Feb)		
	In thousands of tons	In percent	Average muddiness in milligrams per liter	In thousands of tons	In percent	Average muddiness in milligrams per liter	In thousands of tons	In percent	Average muddiness in milligrams per liter	In thousands of tons	In percent	Average muddiness in milligrams per liter
Kamyzyak												
Staraya Volga												
Bakhtemir												

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87 percent of all water-held alluvia is carried in the spring flood, 11 percent during the middle of the summer, and 2 percent in the winter. The maximum discharge of alluvia is (for 1925) 35 days earlier than the maximum water discharge; and the least discharge of alluvia falls in the winter period. In general, variations in discharges of alluvia follow rather accurately variations in water discharges.

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Biocoenosis of Sandy Ground

Sandy ground is found extensively along the Lower Volga, covering nearly the entire river bed. The sand is composed of 65 percent coarse-grain (0.5-0.25 millimeters), and 35 percent fine-grain (0.25-0.001 millimeters). The bottom of the river in the respective sections is smooth. Only in places are there minor deeper spots, uneven, with rocks, etc. The surface of the sand is extremely poorly populated, and the number and variety of inhabitants of this particular biotope is characteristically very small. The leading forms of biocoenosis are are the following: Dreissena polymorpha, Limnoidos fluviatilis, Limnodrilus nouvaensis, Gammarus abbreviatus, platycheir, aurai, larvae Tanypus, Cryptochyronomus, Harmischia, Paraclodopelma. All of these forms are distinguished for the toughness of their structure, having in some instances the ability to stick to the substrata (Dreissena), cover themselves in the ground, and often are predatory. The quantity of animal life on one square meter of the surface varies from 1 to 20, as an average from 55 samplings - 33 specimens. Single specimens of all types are found.

Biocoenosis of Clayey Ground

Clayey ground is found largely along the clayey banks of the river, washed by the current and forming cliffs and steep banks. The bottom is not smooth, the current is more or less rapid, and there are tree trunks and uprooted floating trees. Biocoenosis has little variety, though over time it has a considerable number of differences. The digging forms of this biocoenosis further the destruction of the river bank. Its composition is as follows: Viviparus deboisianus, Dreissena polymorpha, Dikerogammarus haemobaphes, Gammarus abbreviatus,

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Corophium curvispinum, larvae Palingenia, longicauda, Polymitoreys virgo, Hydropsyche vinatula. The quantity of animal life varies significantly depending upon the speed of the current. In a swift current, it is extremely small (2-10 specimens per 0.1 square meter). In calmer locations, (for instance, in coves and river branches), there are up to 276 specimens. In the average, the concentration of population is 60 specimens.

Biocoenosis of Silty Ground.

Silty grounds are typical for places with slow currents and on low banks. Particularly often they are found above the place in the river where the sand bar is deposited or before the place where a tributary flows in. The river benthos includes the following groupings: Dorylaimus stagnalis, Propappus volki, Limnodrilus nowaensis, larvae Culicoides and Tanypus. Most of all here there is oligohet and further, Tanypus. The number of organisms per 0.1 square meter is considerable and it approaches that found on analogous grounds in river branch channels and backwaters. On the average, there were found 26 specimens. This average, however, was derived from 4 samplings, and accordingly the quantitative characteristics cannot be recognized as adequate. (In the Middle Volga, the comparable biotope shows a concentration of population of 50-60 samples per square meter).

Biocenosis of Rocky Ground

Rocky grounds are seldom found along the Lower Volga. Usually they follow the right high bank of the Volga and the corresponding biocoenosis does not play an important part in identifying the benthos as a whole. The population has the following dominant forms: Viviparus duboisianus, Dreissena polymorpha, Monhystera filiformis, Limnodrilus, Pisicola, geometra,

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Dikerogammarus haemobaphes, Gammarus ischnus, obesus, Corophium curvispinum, larvae Heptagenia sulphurea, Hydropsyche ornatula, Orthocladiinae, Cryptochironomus-Harnischia-Paracladopelma. Of these components, the most prevalent are the gammaridae (chiefly the Corophium) and the chironomidae.

The branch channels (rukary) of the Lower Volga usually are not very wide (50-100 meters), have a weak current, with varying depth (from 5-10 meters), sometimes having significant silt deposits along the center of their channels. Often the branch channels (voloshki) develop by gradual stages into backwaters. In the branch channels, several characteristic biotopes and biocoenoses are found. Of these, however, those three which are typical for the Saratov region will be written about below.

Biocoenosis of Sandy Ground.

Almost pure sandy ground is found along the banks of several of the channels or along the bottom, in places where there is a relatively rapid current. The typical forms of benthos are Limnodrilus nawaensis, Gammarus abbreviatus, platycheir, sarsi, Metamysis strauchi, larvae Gomphus flavipes, Tanypus, Cryptochironomus, Harnischia, Paracladopelma, Chronomus thumni. This biocoenosis differs from that of comparable main rivers because of the presence of Metamysis strauchi, Gammarus flavipes, and Chironomus thumni. It differs also in the degree of development of individual forms. In general it is not similar, since it is a poor biocoenosis, having on the average a population of 4 speciment per 0.1 square meter.

Biocoenosis of Sandy-clayey Ground.

This biocoenosis corresponds with the deposits, which are characteristic of the channels of the left meadow side of the Volga valley.

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Here, in addition to sandy-clayey grounds, there also are deposits of rock waste with vegetation, and coarser pieces of vegetation. The depth is considerably great, but the current in comparison with the river, is weak.

The biocoenosis composition is very rich, representing 29 forms. Of these, the most characteristic are: Pelmatohydra obligactis, Viviparus dubuisianus, Sphaerium rivicola, solidum, Limnodrilus hoffmeisteri, newaensis, Glossosiphonia complanata, larvae Gomphus, Palingenia, Polimitarcys, gammaridae Metamysis strauchi, chironomidae (Chironomus plumosus, thumni, Tanypus and others). There are large quantities of some of these forms, such as Viviparus dubuisianus, Sphaerium rivicola, solidum, Limnodrilus hoffmeisteri, newaensis, Glossosiphonia complanata, larvae Gomphus, Palingenia, Polimitarcys, gammaridae Metamysis strauchi, chironomidae (Chironomus plumosus, thumni, Tanypus and others). There are large quantities of some of these forms, such as Viviparus, Limnodrilus and larvae Tanypus, which in places yield up to 1[illegible]0 specimen per 0.1 square meter. The Polypodium hydriforme, a parasite of the sterlet, are found in their stage of unattached living. Infusoria are found attached in sufficiently large quantities. The average quantity of these organisms is 40 specimens per 0.1 square meter, with a range of from 3 to 160.

Biocoenosis of Sandy-silt Ground.

In accordance with this biocoenosis, the places of habitat are located along the channels of the right (higher) main bank of the Volga. The bottom is sandy silt (the absence of woody growth along the banks is characteristic). Depths are from 5-6 meters, usually 2-3 meters. The most characteristic elements of the biocoenosis are counted in 19 forms. There are ~~less~~ fewer crayfish-like, ~~the~~ chironomidae larvae; and there is an

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almost total absence of molluska and digging may-fly larvae. An abundance of lower crayfish-like types is characteristic (5 types: Iliocryptus sordidus, Chydorus sphaericus, Illocypris gibba, Cypris ophtalmica, Cyclops serrulatus), with the presence of Jaera nordmanni, of the insect Apheloheirus aestivalis. In general, there is a great quantity of this form, but their quantitative development is not significant. The average concentration of population is 16 specimens, with a range of from 2 to 70 specimens.

Backwaters of the most various sizes are found in extremely large quantities along the Lower Volga. When the water is at a high level, they are always channelled, but during the usual water level, they are separated from the river by deposits, located at the upper end of the backwater, and making a barrier in the form of sand accumulation or ridge, covered with vegetation. This bar considerably weakens the force of the current, developed in the spring. Accordingly, all silt deposits of a backwater, sometimes reaching considerable size, are not carried away by the stream, but on the contrary, they accumulate new masses of material from the river, principally sand and clay particles. The backwaters afford protection to an extremely rich fauna. The hydrological regime of the backwater during the summer often acquires certain characteristics typical of eutrophic lakes. The number of varieties in the benthos is not particularly large, but their quantitative development achieves great force.

Biocoenosis of Silty Ground in Deep Backwaters

Deep coves have a depth of 8-10 meters. The bottom is covered with thick layers of silt (such backwaters serve for the wintering of ships). There are 25 types in the composition of the biocoenosis. In the springtime when the current is established in a backwater, there

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may be found a number of rheophile forms of Dreissena mizidae and gammaridae. During the middle of the summer, however, they disappear from the composition of the cove fauna, gradually going down to the mouth of the river. Of the river forms, the Viviparus dubois ianus survive longer than any others. These temporary or seasonal cells are not members of the permanent biocoenosis, which typically has oligochaetae chirohata: Limnodrilus hoffmeisteri, cluparedianus, newaensis and chironomidae larvae (Chironomus thummi, bathophilus, plumosus, reductus-plumosus). Oligochaeta can achieve a density of up to 630 specimens per 0.1 square meter. Of the number of crayfish-like types, it is possible to point to Corophium curvispinum (a form evidently most adaptable to life in stagnant water, in contrast to other Volga Malacostraca), and of the lower forms: Iliocryptus sordidus, and to some extent, Cypria ophthalmica. The chironomidae show up to 200 specimens per 0.1 square meter, in which connection it may be noted that Ch. bathophilus as a form preferring more oxygen than Ch. plumosus, is found in deep backwaters only in small quantities. (In the near-bottom layers of water in the deep backwaters somewhat of a deficit of oxygen is noted.) The average number of living organisms is 110 specimens per 0.1 square meter. In certain instances, a biotope of silty ground has a very large population of animal life, as much as 1,164 specimens per 0.1 square meter (which is the maximum figure for the Volga in general).

Biocoenosis of Very Silty Ground in Shallow Backwaters

Depths where this biocoenosis is found do not exceed 2-3 meters. The silt is rich in haphazard impure ingredients. The mouth of such a backwater usually has extremely shallow water. Total absence of rheophile forms is characteristic as also is the development of silt poisons. The heat developed is very strong, usually with a reduction of oxygen

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at the bottom. The biocoenosis is composed of the following forms: Unio pictorum, tumidus, Limnodrilus hoffmeisteri, Tanypus larvae, Ch. thummi and plumosus. All these forms usually are found in the middle of a backwater, while the others keep closer to the banks. The average amount of animal life per square meter is 32 specimens in this biotope.

Biocoenosis of Volga "Karsh" /Washed-out Floating Trees/.

"Karsh" on the Volga is the name for trees which have been washed out by high water and carried along by the river. These are inhabited to a large extent by the characteristic community of cells. Ordinarily these do not present a wide variety of forms, but there is a considerable amount of development among some of them. An important factor here, aside from the nature of the substrata (wood), is the current. In accordance with this, individual types of the karsh biocoenosis differ by a certain aptitude, which makes it possible for them to stick to their location. Very common for these washed-out floating trees is the Dreissena polymorpha which fastens itself into uneven places with its sticky threads. Viviparus viviparus often is found here making use of all deep places and objects. Here, moreover, they are found largely in their early stages. To a large extent, the Hydropsyche ornatula larvae also are typical with their net traps, and the pupae of the same type hidden in their structures. The quantity of larvae in a small uneven space sometimes reaches several hundred. Further, there are the larvae of the Nemreclipsis bimaculata and chironomide larvae, chiefly of the rheophile form, such as Pelopia, Euxiefferiella and various Orthocladiinae. They all build tube-like structures to live in, out of sand and mucus. Corophium, if they are found here, also keep themselves in the same type of structures. The buildings of this animal life lend a specific appearance to the entire community. In addition to these, one can be reminded also of the colonies of bryozoa lying flat against wood: the Fredericella sultana and Plumetella repens and the smooth larvae of the Oligoneuria rhenana.

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4. RIVERS OF THE KAMYSH-SAMARA LAKE BASIN

(a) Bol'shoy Uzen' River

Hydrography

The source of the Bol'shoy Uzen' is on the slope of Obshchiy Syrt, at the village of Miloradovka at 51 degrees 35 minutes North latitude and 48 degrees and 44 minutes East longitude. The length of Bol'shoy Uzen' is 596 kilometers. The area of the watershed is 17,056 square kilometers. The basin of the Bol'shoy Uzen' is assymetrical, and its increment is very rapid at the upper reaches, gradually lessening toward the middle of the river's length. Its largest tributaries, the Altat and Chertanly flow in from the left side and form a sufficiently well developed river network. From the right side, small rivers flow in through wide ravines.

The northern part of the Bol'shoy Uzen' basin lies in the Syrt area of Trans-Volga, and only at the town of Novouzensk does it enter within the bounds of the Caspian lowlands. A spur of the Obshchiy Syrt in the northern part of the region of the Bol'shoy Uzen' acts as a water-divide with an elevation of 120 - 140 meters, and between the Chertanly and the Dyura Rivers, it drops to only 92 meters elevation. Somewhat further south, the plateau is 73 meters high, and at the latitude of Novouzensk, the narrow ridges between the tributaries reach 60 - 65 meters. In the region of the Caspian lowlands, the elevation varies from 25 - 30 meters, and at the water-divide with Malyy Uzen', it is 18 - 27 meters. The wide valley of the Bol'shoy Uzen' River is a 40 - 50 meter deep cut across the surface of the Syrt Plateau. The upper reaches of the valley have a width of 5-6 kilometers, and it is composed of easily eroded clayey and sand-clay soil. In this part of the valley of the Bol'shoy Uzen' some ancient terraces which are not clearly defined may be seen.

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The smooth, wide valley floor is composed of sea and fresh water silt deposits. The river channel cuts into the floor of the valley, often giving the appearance of a deep ravine, up to 200 meters wide and as much as 15 meters deep. Upon entering the area of the Caspian sedimentary deposits, the river valley gradually merges into the plain, which is relatively level with no drainage outlet. Here the river flows into a narrow valley; where its banks rise slightly above the steppe, to form an embankment. The width of the river varies from20 to 30 meters, and at the upper reaches at Novouzensk it is from 50 to 60 meters. Its gradient from the upper reaches down to Aleksandrov-Gay is 0.000150.

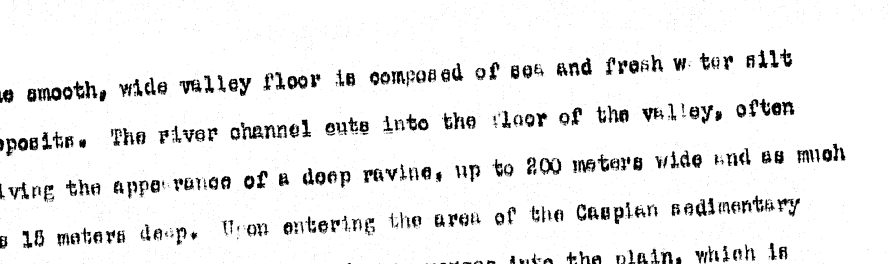
Meters Marker
100
High Water Mark 97.47 on April 17, 1929.
Low Water Mark, 88.71 on 24 March 1928.
Elevation in Meters
Distance in Meters

Figure 75. Cross-section of the Bol'shoy Uzen' River at Osinov-Gay

Figure 76. Graph showing fluctuation of the water level of the Bol'shoy Uzen' River at Osinov Gay.

At the village of Slomokhin, the Bol'shoy Uzen' reaches its greatest depth and width. Here the wide gulleys in the valley are trough shaped with steeply slanting sides. The depth of the river reaches 2.6 meters at average water level. The river valley of the Bol'shoy Uzen' has many dry channels and estuaries, a particularly large number are found along the left bank. Along the entire river there are many

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primitive dams.

Below the village of Slomikhino the river flow diminishes and begins to pour out into the steppe and the run-off goes in various directions toward the Kamysh-Samara lakes, where the Bol'shoy Uzen' finally loses itself.

The Water Cycle and System

The Bol'shoy Uzen' has a brief and violent period of flood when the snow melts. The swiftness of current varies from 0.7 to 1.2 meters per second. At the village of Slomikhino, springtime waters inundate an area of about 20 square kilometers. Then some of the receded water is collected together again into shallow channeled streams which empty into the Kamysh-Samara lakes. Toward the end of April or the beginning of May, the surface run-off water usually stops. Since the Bol'shoy Uzen' is fed almost exclusively by surface run-off water it dries up in certain places and is overgrown with reeds during the summer time. Along practically the entire length of the river at average water level, many springs of water are noted, which fill in the stretches of water between the dams.

In order to study the discharge of the Bol'shoy Uzen', there are water measuring and hydrometric observations made at Novouzensk (see page 292, [in Russian original text]), which have been worked over, and data in the work of Nikoforov (1927 manuscript), and Prozorov (1929 manuscript). In the present essay, the material of Prozorov has been used, supplementing the data of Giprovod. The most complete material is for 1925 and succeeding years. From other points along the Bol'shoy Uzen' River, there is data for the water discharge at Orlov-Gay and Aleksandrov-Gay (archives of State Hydrological Institute), and data on the Altata, its tributary.

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Meters

Cubic Meters per Second.

Figure 77. Curve showing volume of water-flow of the Bol'shoy Uzen' at Osinov-Gay.

Cubic Meters per Second

Figure 78. Graph of fluctuations in volume of water-flow of the Bol'shoy Uzen' river at Osinov-Gay.

Meters

Zero of graph 13.00
Initial marker "OZU"
Number 201. Marker
of 1915 foundation
stone of Cathedral.
Absolute mark=30.056

Figure 79: Graph of the fluctuation of water level of the Bol'shoy Uzen' River at Novouzensk.

Cubic meters per second

Figure 80. Graph of the volume of water-flow of the Bol'shoy Uzen' River at Novouzensk.

Cubic Meters per second

Figure 81. Graph of the fluctuation of water-flow of the Bol'shoy Uzen' River at Nouzensk.

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Meters

Zero of graph=2.60 meters
Mark of the temporary wooden
conical benchmark = 10.00 meters.

Figure 82. Graph showing fluctuation of the water level of the Bol'shoy Uzen' at Aleksandrov-Gay.

Meters Marker 100

High water mark 97.357

Low Water mark
97.77

Elevation in meters

Distance in meters

Figure 83. Cross section of the Altata River at Osinov-Gay

Meters

Zero of graph = 84.20 meters
Initial marker established
on water post 99.049 meters

Figure 84. Graph of the fluctuation of the water level of the Altata River at Osinov-Gay.

The observations worked out for the Bol'shoy Uzen' River are presented in the form of graphs showing fluctuations in water level, tables measuring the volume of flow and hydrographs. The rate of flow was observed with the use of floats.

The observations indicate that the beginning of rising water, at its earliest, comes at the end of February, and at its latest, during the middle of April. The run-off ends in the middle of April, and at its latest, during the middle of May. The longest period of run-off was in 1926. The run-off continues from 18 to 57 days. The highest

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rise was observed in 1927, and the lowest in 1919. Maximum water level was observed earliest of all in 1928 (14 March), and latest of all in 1914 (23 April).

The data in the following table show the amount of water discharge and the levels of the Bol'shoy Uzen' at Novouzensk:

Year of Observation	Beginning of Water Rise	End of receding and run-off	Continuation of Spring floods, in days	Range of variation of water level, in meters	Maximum outflow	Date of Maximum water level	Average outflow	Full out-flow in millions of cubic meters
1914								
1919								
1920								
1924								
1925								
1926								
1927								
1928								
1929								
1930								
Average								
Minimum								
Maximum								

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The year of maximum run-off was 1920. The average was in 1929, and the minimum was in 1928.

The average outflow during the run-off period, for nine years, was 104 cubic meters per second. The greatest out-flow volume per second was observed to be 1210 cubic meters per second in 1920. The average from the largest out-flow volume is 650-660 cubic meters per second. The smallest of the maximum spring out-flow was observed to be 240 cubic meters per second in 1910.

In calculating the annual run-off, shown in the table above, the run-off was also taken into consideration for those days not covered by the observations.

According to 1925 data, the break-up of ice on the river coincided with an almost maximum water level, and the entire rise of the water took place when the river was frozen over. Ice jams are noted in the vicinity of Novouzensk, two kilometers below the water-mark post.

Erosion Action

The bed of the Bol'shoy Uzen' erodes slightly, and the actual cross-section changes often. The waters of the Bol'shoy Uzen' River carry numerous particles of ground, detached from the bottom and from the banks. Below, are shown the deposits removed in 1930 at Novouzensk:

Date of Measurement	Water Level Mark (meters)	Water Spent in Cubic Meters per Second	Sediment spent in Kilograms per Second	Daily Expenditure of sediment in tons	Notes
					Sediment is carried along the entire actual cross-section. The water level and the washing away of sediment are taken as an average of three measurements.
		Average			

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RECORD OF THE FLOW OF WATER OF THE BOL'SHOY UZEN' AND THE ALTATA

Level (Meters)	Flow in Cubic Meters per Second	Date	Level (Meters)	Flow in Cubic Meters per Second	Date	Level (Meters)	Flow in Cubic Meters per Second	Date
Bol'shoy Uzen' at Novouzensk								
Altata at Osinov-Gay								

Note: In order to obtain an absolute reading, it is necessary to add 10 meters to those at Novouzensk, and 88 meters to those of Osinov-Gay.

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According to the data of the Lower Volga project, average mud content of the Bol'shoy Uzen' at Novouzensk in 1932 was 492 cubic meters per year, with an overall run-off of alluvial drift amounting to 240 thousand tons.

(b) Malyy Uzen' River

Hydrography

The Malyy Uzen' starts from the mountain spurs of Obshchiy Syrt, at the hamlet of Obrastsovskiy Khutor, not far from Yermolovo Ural'sk Station, at 51 degrees 22 minutes North latitude, and 48 degrees 20 minutes East Longitude. At the start, the Malyy Uzen' flows south, then it turns southwest, and below the village of Piterka it goes southeast, continuing in this direction until it empties into Kamysh-Samara Lake. The length of the river is 420 kilometers (Nikiforov manuscript).

The northern part of the Malyy Uzen' river basin lies in the region of the Syrt, and the southern part is within the confines of the Caspian lowlands. The overall area of the basin is 12,520 square kilometers, extending the length of the river as follows: Pisarev and Sokolovskiy manuscripts). It includes 2,540 square kilometers to the location of the village of Martovka. At Petropavlovka, 260 kilometers from the mouth of the river, it is 4,360 square kilometers. At Talovka, 139 kilometers from the mouth it is 8,280 square kilometers. The Malyy Uzen' has no tributaries other than ravines and gullies. The overall fall of the Malyy Uzen' is 48 meters. The average gradient along its course according to the Tillo hydrometric chart is as follows: from the headwaters to the village of Perekopnoye 0.001; from there to the village of Piterka it is 0.00024, from which point to the village of Talovka it is 0.00015; and finally in its lower course it is 0.00003.

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The upper reaches of the Malyy Uzen' River have the appearance of a steep-walled ravine. In the Syrt region of the Malyy Uzen' valley ancient terraces can be noted occasionally, but on entering the region of the Caspian sedimentary deposits, the river valley is not so clearly distinguished from the lowlands which surround it. The width of the valley varies from three to four meters [sic, should read "kilometers"] in the Syrt region and narrows down to 150 - 200 meters between Avgustovka and Petropavlovskaya. The clearly defined channel of the Malyy Uzen' goes approximately down the middle of the valley; at its upper reaches its banks are 4 - 7 meters high, and 7 - 12 meters at the lower end of the river. The channel of the Malyy Uzen' is rather monotonous. In the undermashed concave sections, the banks are steep, while in the convex sections, they are fairly sloping. Most frequently, the cliffs are made up of two parts: the upper sheer part (up to 5 meters) and the lower more sloping or shelved part. Such a structure of cliffs depends upon the presence of sandy layers in the rocks comprising the banks. Ordinarily, steep banks are higher than those covered with sod at the turns, but along the straight course of the river (below Avgustovka) their height is the same. As far as the village of Malyy Uzen', the left bank is high and the right bank low and partly washed out. The width of the channel here is 35 - 40 meters. Over its entire course, the Malyy Uzen' has many dams, largely of the primitive type, for holding back the spring waters which are used for irrigation. According to the data of R. P. Sparro [1439], about 24.4 percent of the springtime run-off is spent in filling up ponds and in irrigating 7,554 hectares.

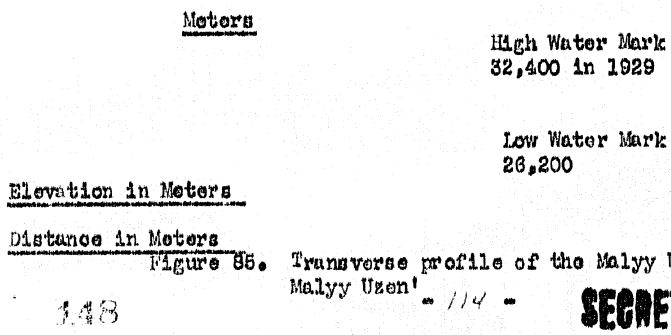

Figure 85. Transverse profile of the Malyy Uzen' River at Malyy Uzen'

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Meters

Zero of graph = 24,20 meters
Initial marker "OZU"
Number 107. 1 marker of
1915 on the foundation to
the western wall of the
cathedral at Malyy Uzen'
Absolute mark = 38.025 meters.

Figure 86. Graph of water level fluctuations of the Malyy Uzen' at Malyy Uzen'.

Water ~~Regime~~ Cycle

The basic ~~feed~~-supply for the Malyy Uzen' is from the spring melting of snow and from rain in the northern part of the basin, also from springs along the bottom and banks which crop out along its entire course. At the end of April and the beginning of May, the surface run-off usually stops, and the ground water fills up the stretches of water between the dams. Observations of the run-off of the Malyy Uzen' at Petropavlovka were carried on by earlier Volga surveying parties, the Volga Colonization Expedition, and the Saratov Guberniya Land Administration. The observations consist of water measurements and float data for the years 1916-1920, 1925 and 1926. The data was worked over by M. Nikiforov (1927 manuscript). Until 1926, curves on the expenditure of water were built up on the basis of incomplete data, or else they did not exist. For such years, water discharge was calculated on an average curve covering the observation period. In 1926 the curve was constructed on the basis of water discharge, measured in rise and fall. In view of the discrepancies in the data for all the years as compared with the more reliable 1926 data, the observation should not be considered as completely reliable. From other points along the Malyy Uzen', there are observations on the passing of springtime waters, at the village of Marshanka for 1914 (archives of the State Hydrological Inst.).

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The water ~~regime~~ cycle of the Malyy Uzen' is marked by ragin spring floods, and the absence of run-off water during the rest of the year. The beginning of spring floods is observed at Petropavlovka at the beginning of March (and in 1926, on 26 February). The spring floods end on the beginning of May (in 1926, on 20 April). The floods last from 54 to 69 days. The variation in the rise of water was from 1 meter during the small 1918 spring flood, to 6.5 meters during the full-water flood of 1920. The average muddiness of the water of the Malyy Uzen' at the village of Malyy Uzen', was in 1932, according to the data of the Lower Volga Project, 428 milligrams per litre, with an overall run-off deposity of 134,000 tons.

In order to characterize the chemical affinity of the waters of Bol'shoy and Malyy Uzen', ~~there were used~~ two brief analyses (one for Mavrinka Station on the Bol'shoy Uzen and one for Piterka on the Mally Uzen'), were used.

Cubic Meters per second

Figure 87. Graph showing the fluctuations of water expenditure of the Bol'shoy and Malyy Uzen' Rivers.

Meters

Figure 88. Graph of water-level fluctuations of the Malyy Uzen' River at Petropavlovka.

The test readings made refer to the headwaters of Bol'shoy and Malyy Uzen', and, accordingly, can be taken to describe only a limited section of these rivers. In view of the imcomplete analysis, these data are presented in the form in which they were given in the original (Koshe-

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lyayev, 621). (Analysis is given in milligrams per liter).

	Date	Dry Remainder	Calcined Remainder	Hardness General	Hardness Permanent
Bol'shoy Uzen', at Lavrinka Station	January 1914				
Malyy Uzen', at Pitorka Station					

In the written data there are indications that the w ters of the Uzen' rivers nd the Aanysh-Samara lakes are highly mineralized.

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B. LAKES

General Data on the Lakes of Nizhneye Povolzh'ye

The overall number of lake-like reservoirs along the Lower Volga t at the present time, in the absence of sufficiently detailed maps, cannot be exactly established. The 10-verst scale VTU maps, which exist for a large part of this territory, do not give adequate material to judge the number or configuration of the lakes. A considerable number of the lakes indicated on the 10-verst scale map, at the present time do not exist, or have turned into salt marshes, or else have become overgrown (as, for instance, several of the reservoirs of the Sarpinskiy Lake system). A large part of the region has typical salt lakes, often turning into salt marshes and salty muds. Strictly speaking, fresh water lakes are very few, largely the shallow flood-plain reservoirs and dried-up river channels of the Volga system, the group of Sarpinskiye lakes (a number of which have become quite salty), fresh water estuaries of the left bank of the Volga and marshes of the Volga delta. The vast majority of the other lakes of the territory are salty and bitter-salty lakes with the most varied concentrations of salt, depending upon the extent of deposits and other characteristics of the lakes, with many intermediate steps from the genuine salt lakes to the gradually drying salt flats and salty muds. It can be noted that only the southern half of the area south of the 50th parallel is to be distinguished by its large number of lakes. The entire northern half has an insignificant number of lake-like reservoirs, located largely in the river valley of the Volga. In the southern half, on the other hand, there are lake formations of various sorts. Particularly the salty ones are very numerous.

According to their location on this territory, first of all should be noted the groups of large lakes: El'ton, Baskunchak, Gorkoye, Botkul',

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Aral-sor, Bol'shoy Sakryl (or formerly, Solenoye Ozero), and Malykta. All of the above listed lakes are salty. The best known of them are Basunchak and El'ton. The Sarpinskoye lake system is a considerably large group, located in the western part of the southern half of the region. Southeast from the chain of Sarpinskoye lakes, there is found a small group of which the principle ones are Bol'shoy and Malyy Altsyn and Shor-tolga. On the southernmost extreme, within the limits of the hydrological area, there is located a small group headed by Sostinskoye, Keke-umun' and Mozharskoye lakes, which are the remnants of old river beds of the Manych River. Finally, in this area, i.e., to the right of the Volga, there is located a large group of lake-like formations, known as il'mens (marshes), forming a close network of reservoirs, west of the right Bakhtemirovskiy Channel of the Volga, commencing at Astrakhan' and going clear to the sea. The numerous small salt lakes follow along the entire left bank part of the Volga, particularly to the east from the meridian of El'ton and Baskunchak lakes. This entire part of the Nizhneye Povolzh'ye area has the most closely concentrated network of lakes, which incidentally, consist primarily of half-dried small salty lakes, and salt marshes. In the northern half of the left bank area of the Volga, largely on the territory of the former Nikolayevsk Uyezd, there is a considerable number of fresh-water reservoirs (though largely dried up during the summertime), known here by the name of liman (estuary). The largest group forms the system of Prishib Moguta limans. These are located 40 kilometers southeast of Kamyshin. Finally, it is necessary to call attention to a significant group of the Kamysh-Samara lakes, located along the lower reaches of the Bol'shoy and the Malyy Uzen' rivers.

In spite of the significant amount of literature that there is concerning the lakes of the region, certain of them have been studied

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altogether insufficiently, with the exception of El'ton and Baskunchak, about which there is the large number of printed works. The other lakes in the area have extremely little substantial material written about them, concluding with very little data for a concrete monographic description of the individual lakes. Most of the work is limited to enumerating and giving the briefest information about individual lakes. Accordingly, questions as to the type grouping of the lakes of the region, at the present time, cannot yet be adequately worked out.

In the characterization of lake groups which is given below, and of the individual better-studied lakes, the following grouping is accepted practice:

1. Alluvial washed reservoirs of the Volga and its tributaries.
2. Marshes and high-water inlets of the Volga delta.
3. Small fresh-water lakes of the elevated areas along the Nizhneye Povolzh'ye.
4 - 5. Sarpinskoye and Kunysh-Samara lakes.
6. Salty lakes of the lowlands bordering the Caspian.

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5. KANYSH-SAMARA LAKES

General Considerations

The Kanysh-Samara lakes are a closed system of reservoirs, located at the edge of the steppe (Kanysh-Samara), and a wide band of sand dunes. The climatic conditions of the vicinity of the lakes are semi-desert. There are severe fluctuations in the temperature of the air, strong winds, quick evaporation with a small amount of precipitation, and drought-resistant vegetation. The development of Solonchak type soils is characteristic of the area where these non-discharging lakes are located. Variations in the degree of the salt-content of the soil and the varying degrees with which they are connected with the Bol'shoy and Malyy Uzen' rivers, whose waters supply them, is what creates different types of lakes in terms of salt content. The lakes are usually not more than 2.0-2.5 meters deep. Sometimes, they are of significant size (up to 5-6 kilometers in length). They are of no particular shape. The amount of water in them, and at the same time, their saltiness, changes radically in the summer, depending upon the amount of drought.

Concerning the group of Kanysh-Samara lakes, some information of a brief nature is available on the following lakes (Meysner, 85):

Verkhneye or Tomak Lake

On the 10-verst scale map it is indicated under the name of Saraydyn-sagas, as a small round form surrounded on all sides with a thick border of reeds, going far out into the lake itself. The lake is very shallow, not more then 0.5 meters deep. The water is rather muddy, and completely without life and with a decided salty taste. The

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Sary-kulak Lake

It is located at 48 degrees, 59.2 minutes North Latitude, and 49 degrees, 56.0 minutes East Longitude. It is the typical example of the estuary type lake, a large number of which are included throughout the Kamysh-Samara system of lakes. This narrow lake, drawn out in a latitudinal direction, is bow shaped. It is about 4 kilometers long, with a width of from 100 to 400 meters. Toward the eastern and northern shores of the lake, it borders upon salt marshes overgrown with saltwort (Salicornia herbacea). The shore-line water vegetation consists of reed grass intermittent with reeds (Scirpus), and further into the water there is cat-tail flag (Typha) or reed cane (Phragmites). In the lake itself fluffy weeds of the Ceratophyllum variety grow from the bottom. In the widest place in the middle of the lake, the depth barely reaches 1.5 meters. The shores of the lake are so washed down that at 100 meters from the shore, the depth of water is not more than 20 centimeters. In many places the shore shows clearly the washed area of the cane banks, standing 200 to 300 meters out into the lake.

The water is absolutely non-potable, and it is saltier than that of the discharging Kamysh-Samara lakes. The hydrometer showed 1.0043 at 27 degrees Centigrade. In the opinion of V. Meysner, the origin of these estuary type lakes is due to the winds, by which they have been eroded into basins filled with water. That is why they are so very variable. While one of them gradually fills up with sand dunes, others reappear. The large Rybnyy Sakryl Lake may be included in the group of Kamysh-Samara lakes, although it is located considerably to the north of this group of lakes.

Rybnyy Sakryl Lake

It is located between the Bol'shoy and Malyy Uzen' rivers at 39

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hydrometer reading gives its specific gravity as 1.0023 at 19.3 degrees Centigrade. The bottom is covered with a thick layer of greyish-black liquid silt (batpak), and it is completely free from weeds. The Bol'shoy Uzen' River flows through the lake.

Staritskoye (Ak-Suat) Lake

It is located at 48 degrees, 55 minutes North Latitude and 49 degrees, 5.7 minutes East Longitude. It is twice the size of Tomak Lake, has an irregular triangular shape, with the largest axis about 1.5 kilometers long and with a width of about 1 kilometer. The depth is insignificant, not more than 1.5 meters, and in most parts of the lake it is not over 1 meter deep. The bottom is covered with a grey-black silt and with a sufficiently strong growth of Ceratophyllum weeds and characeae. The lake is heavily populated with water fowl. To the taste, the water is very slightly salty, although the hydrometer showed a specific gravity of 1.000. The channel of the Bol'shoy Uzen' goes through the lake. It is heavily grown up with reeds; and it joins the Staritskoye with the next lake which is the Korabl'.

Korabl' Lake

It is one of the largest in the system of the Kamysh-Samara lakes. It is about 4 kilometers long and about 2 kilometers wide. The lake is uneven in shape, with a sharply cut shore line drawn out in a latitudinous direction. In depth, nature of the banks and the bottom, the vegetation and fauna of the lake in no way differs from that of the lakes described above. The only difference is its size and the number of islands overgrown with weed grasses, drawn out along the southern shore. The channels of the Uzen' also wash this lake, entering it from the northwest and leaving by way of the northeast.

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degrees, 37.3 minutes North latitude and 49 degrees, 12.8 minutes East Longitude. It is about 9.3 kilometers long, with a maximum width of 3.2 kilometers. The lake is triangular in shape, with its widest angle in the northwest. The northern and western shores are only slightly irregular, while the southeastern shore in contrast, is very meandering, forming the Cherkost Peninsula which goes far out into the lake. The peninsula divides the lake into two stretches of water: the northern Bol'shoye More (Big Sea), and the southern Maloye More (Little Sea). The entire shore-line is gradually sloping and low. At a distance of from 300 to 400 meters from the water, there are terraces, 4-5 meters high, forming the basic shore. Terraces surround the lake from the east, north, and northwest exposures; and it is lower at the peninsula. The lower part of the shore is covered with deposits of salt and shoots of the saltwort (Salicornia herbacea). Closer to the shore-line, there is an overgrowth of reeds (Typha latifolia). Further, there is the wide border of cane (Phragmites communis), which extends into the lake itself. The overgrowth of cane reaches 5 meters in height, and in places it spreads out forming meadow-like areas reaching up to the shore-line. The water balance of the lake is maintained by the Sakrylka River, which completely dries up during the summertime, but brings much fresh water into the lake during the spring from the Bol'shoy Uzen' River. With the receding of water in the Sakrylka River, for a certain time the water from the lake flows back into the Uzen'. In this way, there takes place annually a renewing and sweetening of the lake with fresh water. In those years with little water, however, the lake is deprived of an inflow of water, and it shrinks. This lays bare the overgrowth of the bottom and the shores; and of course, with the accompanying sharp increase in salt content, many fish die. During the summertime the water is not suitable for drinking. The hydrometric reading gives the specific gravity of the water as 1.000. The lake is distinctive for its wealth of fish.

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(b) Lakes El'ton and Baskunchak

General Information About Lake El'ton

The geographical position of Lake El'ton is at a latitude of 49 degrees, 05 minutes and a longitude of 46 degrees, 42 minutes. The lake is situated approximately 1.5 kilometers from El'ton Station on the Ryazan'-Ural'sk Railway. The absolute height of the lake is negative and consists of 14.7 meters. The area of the lake is 151.9 square kilometers. Its greatest length is 20.5 kilometers and greatest width -- 14.8 kilometers, while the length of the shoreline is 59.3 kilometers. The lake has an elongated circular shape, a little drawn out from southwest to northeast. The shores are very sloping and smooth, but in some places on the western side they rise from 6 to 14 meters. On the western and eastern side of the lake there are hills which rise to a height of 20 meters. The ground of the shore is muddy and swampy; the subsoil surrounding the lake is composed of layers of various clays. On the periphery of the lake a deep stratum of black, salty mud stretches in a wide strip (400 meters).

The geological surroundings of the lake are described in detail by P. A. Pravoslavlev (304). The Caspian deposits around the lake consist chiefly of shallow formations, conglomerates, sands and sandstone clays; they irregularly cover the unevenly eroded Paleogenic and Mesozoic layers which emerge from a horizontal position. The geological origin of the hollow of the lake (Tutkovskiy, 141) is explained by techtonic fissures, as detected in investigations of Jurassic, Cretaceous and Triassic layers on the eastern shore of the lake, on Ulagan Mountain and in eroded folds of Cretaceous and Triassic layers on the western shore of the lake. During the period of inundation by the Caspian Sea, its

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water from time to time filled the hollows of the lake. With the onset of the post-Ice Age regression of the Caspian, the great bulk of the lake's salt was deposited in its hollows and afterwards was partly eroded. The hollow of the lake itself underwent intensive weathering at the same time. Under the conditions of contemporary climate there began and continues annually the lixiviation of salt from the soil in the surrounding vicinity and the transmission of these salts as an annual deposit into the lake.

A cross-section of the grounds in the Sorochiya ravine near the lake showed the following stratifications (Stopnevich, 112): (1) yellow clay 0-3.0 meters; (2) gray clay 3.0-5.5 meters; (3) yellow argillaceous clay 5.5-9.1 meters; (4) gray argillaceous clay 9.1-10.1 meters; (5) yellow clay 10.1-14.6 meters; (6) yellow fine-grained sand 14.6-16.6 meters; (7) gray fine-grained sand 16.6-40.6 meters; (8) dark gray fine-grained sand 40.6-46.6 meters; (9) an interstice of gray clay 46.6-46.9 meters; (10) dark gray sand with detritus 46.9-50.0 meters; (11) an interstice of gray clay 50.0-50.3 meters; (12) fine gray sand 50.3-50.6 meters; and (13) a gray clay 50.6-50.9 meters.

The Paleogenic deposits comprising the Ulagan elevation and situated east of the lake, are composed, according to Pravoslavlev, of bluish and yellowish-gray siliceous clays, chalky white writing chalk and bluish-gray marl and crumbly yellowish limestones; the Jurassic deposits are composed of dirty gray limestone clays and limestones.

Eight small rivers flow into the lake. From the western side -- the Solyanka and Lantsukh; from the northern side -- Ulan-zakha, the Khara-zakha (about 96 kilometers long) and the Chernavka; from the eastern side -- the Bol'shaya Smorogda; and from the southern side -- the Malen'kaya Smorogda and the Karantinnaya. In addition to them, several

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springs flow into the lake. The lake does not have an outlet. In the calm weather during the hot period, when there is little water in the lake, springs can be seen, pulsing from the bottom of the lake. Most of the streams flow the whole year round, but they especially abound in water in the spring, increasing the depth of the natural brine of the lake to 1 meter. All the above mentioned rivers supplying the lake have salt water, but on the northeastern shore there are also powerful sources of fresh water. Fresh ground waters are found also in the small ravines along the southeastern shore of the lake. Around the lake there are many different mineral springs.

The hydraulic data about the levels, water balance, and temperature of the lake are numerous. In 1913 and 1914 investigations of the radio-activity of the dirt were conducted (Zernov, 1914). The radio-activity of the dirt at El'ton at the railway hospital equals 71.6 volt leakage, opposite the confluence of the Bol'shaya Smorogda -- 79.5 volts, for the iron rich mineral spring -- 66.9 volts, for the water of the Saline mud spring -- 34.0 volts, and for the lake's natural brine and dirt -- 43.6 volts. The specific gravity of the Iron and Saline mud springs is not more than 1 degree Baume. Their temperature is constant the year round: the saline mud -- 7 degrees, and the Iron -- 9 degrees. The water in the springs has an unusual transparency (it is almost invisible in a glass) and possesses definite curative qualities.

Observations of the temperature of the natural brine of the lake, conducted by N. Rozo (602) 21 - 25 August 1914 showed that it changes very rapidly depending on the solar radiation, fluctuating within the bounds of 22.2 to 30.0 degrees.

A thermometer placed 20 meters from the dam, to the east, at a

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depth of 20 centimeters (the bottom of the lake) showed: for 21 August at 4 o'clock in the morning -- 27.3 degrees; for 22 August at 10 o'clock in the morning -- 25.9 degrees; for 23 August at 8 o'clock in the morning -- 22.2 degrees; for 24 August at 10 o'clock in the morning -- 24.3 degrees; for 25 August at 2 o'clock in the afternoon -- 30.0 degrees.

The depth of the stratum of natural brine in the lake fluctuates from 6-13 centimeters to 1 meter, depending on the time of year and the number of deposits. In the spring time the whole surface of the lake is covered with natural brine, on which the winds sometimes cause a rather strong swell and breakers. The color of the natural brine before the sun sets has a golden shade, as a result of which the lake bears the name of Altan-nor ("Golden Lake") among the Kalmyks. According to the data of Luchinskiy (78) the color of the water (natural brine) changes from pale rose to blue-violet.

There are data about the Smorgda River, in which, thanks to the inflow of springs, which differ in composition, there was observed the appearance of an accumulation of heat, shown in considerable thermal stratifications (Shtaub, 156). For example, at a temperature of 20 degrees on the surface of the river there was a temperature of 24 degrees at a depth of one-half to three-quarters of a meters, and one of 14 degrees at the bottom at a depth of 2.5 meters. The density of the water was irregular: at a depth of one-quarter of a meter -- 0.5 degrees Baume; at a depth of three-quarters of a meter -- 21 degrees Baume; and at the bottom 25.7 degrees Baume. During hydrobiological investigations on 26 September 1925 the temperature of the water in the lake was taken and was shown as 21 degrees (at 19^h) with a salinity of 12.5 degrees. Around the confluence of the Khara-zakha River the temperature was 24.5 degrees (about 15^h). The usual summer temperature of the air at El'ton is about

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35 degrees, but in June and July it frequently reaches 60 degrees.

The shore vegation of the basin of Il'ton was examined closely in 1925 by N. M. Il'in (302), who divides it into 5 belts: (1) wet salt marshes; (2) crusted salt flats blended with Suaeda physophora, Anabasis salsa and others; (3) transitional blended with Anabasis Aphylla; (4) crystal with Anabasis ramulosissima and Artemisia pauciflora; and (5) white mugwort with Artemisia, maritime steppe. These belts are spread unevenly; one wedges into another.

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General Information about Lake Baskunchak

The geographical location of the lake is at a latitude of 48 degrees 13 minutes, and a longitude of 46 degrees 53 minutes E. The area of the lake is 105.5 square kilometers, the maximum length is 19.3 meters, the width 10.2 kilometers. The depth of the saline water is not greater than 10 centimeters, at the west shores a little deeper. The circumference of the lake along the shore is not greater than 52.4 kilometers. The absolute elevation of the lake is 19.5 meters. The lake lies much lower than the surface of the steppe surrounding it, as a result of which the shores are rather high. The west shore is the highest (8.5 meters), the south shore slopes and gradually rises to Bol'shoy Bogdo Mountain (173 meters high), the northern and eastern shores are lower and eventually fuse with the steppe. At the lake itself (in the southern and southwestern parts) the shore forms a steep slope, 2 meters high (Tutkovskiy, 141). Behind the escarpment, bordering the lake, runs a narrow argillaceous strip, which consists of muddy Caspian argillaceous clay, behind which, up to the shoreline, there stretches a wide (500-600 meters) snow-white beach. The salty crust of this beach consists of layers of salt formed annually by evaporation of brine, with a thickness of 3-5 centimeters, which harden at the beginning of the summer.

The geological soil structure of the shores of the lake, according to Bobyatinskiy (267), is given in the information below. In the cut, starting with layers nearest the shore, the strata are deposited in the following order: (1) a reddish-yellow clayey sand, 5 centimeters thick, in which there are pebbles, (2) a la-

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yer of coffee-colored clay, interstiaed with a carbonate 1.1 meters thick, (3) a small layer of clay of a violet shade, composed of $CaCO_2$, 8 centimeters thick, (4) a layer of yellow sand 2.5 centimeters thick, (5) a yellowish-red clay, interstiaed with $CaCO_3$ 8 centimeters thick, (6) a grayish-yellow sand with brownish spots of Fe_2O_3 5 centimeters thick, and (7) a grayish-yellow clay, 5 centimeters thick. In the clayey sand petrifications occur: Dreissena, Cardium, Monodacna, and others. The composition of the second cut is as follows: (1) a yellow, somewhat clayey sand with petrifications and pebbles, (2) a thin layer of sand with white spots of carbonate origin, (3) a lightly clayey sand of a grayish-yellow color with brownish spots.

In the southern part of the lake in 1883, beds of sulphur ore were uncovered near the shore. Their stratification was as follows: a layer of variegated clays, 1.3 to 2.1 meters thick, under which was a layer of sulphur 2.8 meters thick, and under that a dark green laminated clay, 2.8 meters thick and further grey sands and sandstones. In the sulphur layer there are gypsum crystals. The layer is 44.436 percent sulphur; according to V. Skvortsov (641) -- in all 21 percent. Besides this, in the vicinity of the lake, forming a ring around it, there are beds of gypsum. The outlets of the richest layers of gypsum are on the western and northwestern shores. On the western shore there are spacious, long caves and here many cave-ins take place in the soil. In the southwestern part, in the coastal strip of the lake there is a layer of reddish-brown ocher, 2 meters thick, containing 22 percent iron oxides and having the qualities of a good paint.

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The geological origin of Lake Baskunchak is explained differently by different writers. P. A. Pallas (105) thought that the lake was formed as a result of lixiviation by rock salts found in the inner recesses of Bogdo Mountain. Ye. Clushkov (1559) considered the lake to be the remains of an enormous bay which disappeared under the erosive action of strong winds. V. V. Markovnikov (628) spoke of the formation of the Astrakhan' lakes, among them Lake Baskunchak, by the waters of the Volga. P. A. Tutkovskiy (141) gives the following explanation for the origin of the lake. The lake basin, in his opinion, was formed by structural means, disjunctive dislocations, Triassic upheavals, and other deposits on the southern shore of the lake which appear as anticlinal folds and crosses (the town of Bol'shoy Bogdo). The northern wall of this fold, lowering itself, created the structural basin which is occupied by the lake today. During the Ice Age and inundation of the Caspian Sea, Bol'shoy Bogdo Mountain was an island, around which, for a considerable length of time, various Caspian deposits were made, some of which occasionally fell into the basin of the lake itself. The depositing of salts in the Caspian sedimentations by the present day steppe took place chiefly in the post Ice Age, when the arid climate caused the dehydration of the Aral-Caspian basin. These prolonged processes of weathering carried away part of the salt deposits in the basin. With the approach of the contemporary climate there began the lixiviation of salt from the soil of the surrounding locality by the spring and rain waters and the accumulation of these salts in the basin of the present day lake, which, over the course of many centuries, has formed a salt deposit which almost fills the entire basin of the lake.

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The bottom deposits of the lake are layers of salt of varying structure and potency, which have a somewhat varying distribution in different parts of the lake. An examination of the thickness and form of the bedding of the salt layers was first done by drilling in three sinkholes in the northern, southern, and middle parts of the lake in 1883 by Ye. Glushkov, (1859). The drilling showed that in the middle and southern parts of the lake under the top layer of salt, 6 to 8 meters thick, there is imbedded a plastic clay 20 meters deep, under that a second salt layer 2 meters thick, under this the same clay, and at a depth of 34 meters a third salt layer of unknown thickness, in which drilling had proceeded a little more than 10 meters. In the northern part of the lake under the layer of salt formed annually as a result of the evaporation of brine, there is located at 4- 8 centimeters a layer of hard "pig iron" or "lead" salt, 20 to 50 centimeters thick, and beneath it a layer of pure, crystal salt with 98 percent sodium chloride, called "granatka." A square of 56 square kilometers was covered in a gravimetric survey of the south-eastern and southern part of the lake, conducted in 1928 by GGRU. Light drilling of about 500 meters depth was conducted between the upper and lower layers, with a mean depth of 6.93 meters. The drilling gave the following results for the determination of the separate layers: the layer of salt formed annually as a result of the evaporation of brine -- 6.74 meters, root salt -- 33.22 meters, pig iron salt -- 68.40 meters, granatka -- 103.40 meters, granatka adulterated with mud -- 23.30 meters, rock salt -- 14.43 meters, mud (with crystals of salt) -- 91.18 meters, sand -- 33.05 meters, clay -- 24.65 meters.

The chief kinds of Baskunchak salts are these: (1) Novoadka -- an exploitable upper layer of crumbly, crystal salt, consist-

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ing of NaCl with an admixture of calcium chloride, potassium, calcium sulphate, and magnesium bromide; (2) "pig iron" or "lead" -- a harder monolithic salt with little admixture; (3) "granatka" -- a large-crystalled, white, transparent salt with a 98 percent NaCl content, of most value in industry; in the northern part of the lake it is called "compact granatka," in the southern -- "stolbnyak."

The reserves of salt in the lake are reckoned differently by different authors. According to P. A. Pravoklavlev (386), the annual formation of salt layers, as a result of being carried into the lake by atmospheric waters flowing from the surrounding area, and as a result of salt springs opening up in the northern part of the lake, comprises about 450,000 tons. The calculation of some already developed stores gives a total of 750 million tons of salt. If one takes into account the lower-lying layers, 19 meters thick, then the total store of salt of the lake comes to approximately 2.6 billion tons. According to later data (Levenson, 1570), the total amount of salt reserves in the lake comes to not less than 22 billion tons. According to V. Skvortsov (642), the reserves of magnesium salts in the lake are capable of yielding about 1639 thousand tons.

The lake is supplied chiefly by saline springs which exit from the foot of Bodgo Mountain. Mention ought to be made here of the Gor'kaya River and two ravines -- Kordonnaya and Surikova, when we speak of salt streams which empty into the lake.

Hydrological information concerning the water levels, the water balance, the currents, and the temperature is rather sparse. In the opinion of Ye. Glushkov (1559), the lake is supplied by springs which come up out of the lower-lying layers of salt. In

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the hard salt layers there are crumbly holes out of which air and saline water emerge with some force when the debris is removed. The whole southern part of the lake is punctured by an innumerable amount of apertures and pores through which subterranean springs saturated with salt emerge to the surface. The northern part of the lake is abundantly covered with fissures and wells.

The water or natural brine of the lake has a very salty taste and an aquamarine color. The natural brine in the lake in the summertime, with the exception of the northwestern corner, almost completely evaporates, and the lake turns into a snow-white plain with a dry, hard, salty covering.

The flora of the mugwort-covered steppe surrounding the lake has, chiefly, the following makeup: different kinds of mugwort -- Artemisia fragrans, monogyna rigida maritima, Camphorosoma ruthenicum, Kochia prostrata, hyssopifolia, Brachilepis salsa; the typical Festuca avivea; among cereal grains -- Triticum repens, and less frequently appearing -- a special kind of feather grass of "tyrsa" Stipa Lessingiana. The flora of the humid salt flats in the vicinity of Baskunchak has been examined in detail by V. Artsimovich (984). He gives the following table of ontological categories.

Salt Flats	Elements of the Sea-shore Bottom	Deep quicksands
Halophytes of wet sand flats, clearly not preferring strongly sandy soil.	Halophytes of wet salt flats which grow exclusively in places where sand predominates	Halophytic samophytes

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Salt Flats		Elements of the Sea Shore Bottom	Deep Quicksands
Frankenia, Frankenia L., Fr. pulverulenta L., and in general a majority of plants that grow on salt flats	Aeluropus littoralis, Suaeda altissima, Nitraria Schoeberi	Elymus gigantus	Artemisia tschernieviana, forms of Corispermum
		A special crawling Atriplex laciniatum, Agriophyllum arenarium.	

Hydrochemistry of Lake Baskunchak

All the chemical components of the lake exist at all times in two states: liquid (natural brine) and solid (charging salts), which change their states and react reciprocally. The salts lie on the bottom of the lake in a thick layer, which consists of large numbers of strata with interstices of mud. In 1927 a borehole 256 meters deep was made in the center of the lake, and it was filled entirely with salt with small interstices of a clayey, dead layer. In an analysis, of which the results are given below, the salt of Lake Baskunchak was found to be of fine quality, since it consists almost exclusively of NaCl with a negligible amount of admixture.

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The layer of salt formed annually as a result of the evaporation of brine (Kydnshev, 625)	Deep-well salt (Gornoye Upravleniye, year 1913)	Pulverized lump-salt (Astrakhan' Sanitation Laboratory)
Insoluble remains		

All ground waters and almost all rivers which flow into the lake are more or less salt and therefore are the sources by which the salt in the lake is renewed. According to the approximate calculations of A. P. Nikolayevskiy (598) in a year the springs bring about 525,000 tons of NaCl into the lake.

The natural brine of the lake varies all the time in quantity and composition, the variation depending largely upon meteorological factors. The influence of rains falling on the mirror of the lake is not great. The waters of the surface flow and the ground waters, which, in turn, are closely interrelated with climatic conditions, have the largest influence on the level of the natural brine and on the concentration of the chemical components. The flow of water to the lake increases in the autumn, chiefly in November, the second influx comes in the spring months, but all of it evaporates. The smallest amount of water is present in the summertime, and in January and February. The relationship between the amount of water entering the lake and the specific gravity of the natural brine are characterized by the following data (Nikolayevskiy, 598):

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The layer of salt formed annually as a result of the evaporation of brine (Kydryshev, 623)	Deep-well salt (Gornoye Upravleniye, year 1913)	Pulverized lump-salt (Astrakhan' Sanitation Laboratory)

Insoluble remains

All ground waters and almost all rivers which flow into the lake are more or less salt and therefore are the sources by which the salt in the lake is renewed. According to the approximate calculations of A. P. Nikolayevskiy (598) in a year the springs bring about 525,000 tons of NaCl into the lake.

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Month	Monthly Water Inflow in Millimeters	Evaporation in Millimeters	Change in level of natural brine, in millimeters		Mean specific gravity of the natural brine	Mean temperature of the Natural Brine
			Increase	Decrease		
August						
September						
October						
November						
December						
January						
February						
March						
April						
May						

Of the chemical ingredients, the chlorine ion and the sulphate ion were detected most completely and systematically (in some months, from day to day). The following is a composite table of the changes in these ions per month, where their content is indicated in percent, and the specific gravity of the natural brine is reduced to a temperature of 17 degrees.

Month	Mean Specific Gravity	Content of the Natural Brine in Percentages		Relationship of $\frac{Cl'}{SO_4''}$
		Cl'	SO_4''	
June				
July				
August				
September				

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October

November

December

January

February

March

April

May

These data say (1) that the content of the chlorine ion and the sulphate ion in the natural brine is subject to a continual fluctuation in which the content of the chlorine ion invariably increases when the specific gravity increases, and the content of the sulphate ion increases when the specific gravity increases but to a limit and then falls again, (2) the content of SO_4'', in the natural brine, generally speaking, is very negligible (the smallest relationship of $\frac{Cl'}{SO_4''}$ is 124.5 even, and the largest 233.6); therefore the content of sulphate salt in comparison to chloride salt is negligibly small; (3) the natural brine is richer in sulphate salts in the winter and spring; in the summer their content begins to decrease and reaches a minimum in September and October, after which it again increases. A full analysis of the natural brine in respect to salts is given in the table on page 352.

Complete analyses of the natural brine of Lake Baskunchak for each month do not exist. For the three summer months it was necessary to take data from different springs, but the three inserted analyses refer mainly to separate years, of which one (by Erdman) was done more than a hundred years ago. Nevertheless these analyses can round out the incomplete picture of annual measurements of the composition of the natural brine. The table shows the predominant

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MEASUREMENT OF THE SALT COMPOSITION OF THE NATURAL BRINE IN LAKE BASKUNCHAK AT DIFFERENT TIMES OF THE YEAR

Time at which Specimen was Taken and Name of Examiner	Specific Gravity of natural brine at 17 degrees	Content in Percentage of Weight of Natural Brine						Totals of Chloride Metals	Content in Percentage of Dry Remains					Relationship of Na Cl to the Total Sum of Remaining Salts	Na Cl	Mg Cl
		Dry Remains	Na Cl	K Cl	Ca Cl_2	Mg Cl_2	Ca SO_4		Na Cl	K Cl	Mg Cl_2	Ca Cl_2	All Chlorides	Remaining Salts		
1. 22 January (Nikolayevskiy, 598).																
2. 12 February (Nikolayevskiy, 598).																
3. 7 March (Nikolayevskiy, 598).																
4. 20 March (Nikolayevskiy, 598).																
5. June (Gebel' 207-a)																
6. July (Fedchenko, 1597-a).																
7. August (Erdman, 661-a).																
8. 11 August (Nikolayevskiy, 598).																

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9. 16 September (Nikolayevskiy 598).

10. 18 October (Nikolayevskiy 598)

11. 28 November (Nikolayevskiy, 598)

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(1) Except for this, $Mg\ SO_4$ - 0.09

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significance of chlorides in natural brine, the chief place of which belongs to sodium chloride. Calcium sulphate is found mixed in with the chlorides to a negligible extent.

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According to the salt composition of the natural brine, the lake is a typical example of self-depositing salt lakes of Class II, agreeing with the classification of V. S. Kurnakov (the coefficient of metamorphization of natural brine $\frac{MgSO_4}{MgCl_2}$ for Baskunchak is equal to zero). According to the more detailed classification of N. P. Krotov, Baskunchak belongs to the fourth type under which are grouped lakes with natural brine containing NaCl, small amounts of $CaSO_4$, no $MgSO_4$, but having $MgCl_2$, with which a certain amount of $CaCl_2$ is united. The relative amount of different salts in natural brine changes very significantly depending upon the time of year and the specific gravity of the brine. Sodium chloride is found in natural brine in the greatest relative amount during the deep winter and before spring (85.10 percent and 85.36 percent -- in the beginning of March). In the autumn its content falls significantly because of the settling of this salt. In contrast to this, most soluble salts such as $CaCl_2$ and $MgCl_2$ increase greatly in quantity during the autumn, and decrease in the winter. The content of calcium sulphate salt is smallest in the autumn, when the specific gravity is 1.221; therefore it rises and in the second half of January (when the specific gravity of the brine is 1.108) reaches its maximum, but later drops sharply. All analyses show that there is absolutely no magnesium sulphate (bitter) salt in the brine. Only Erdman's analysis gives

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a very small content of this salt, and in comparison with other analyses, an increase in the content of calcium sulphate salt in the summer brine.

Hydrobiology of Lakes El'ton and Baskunchak and Their Vicinity

Data on the aquatic fauna of El'ton and Baskunchak giving the general character of zooplankton are only relatively recent (Kening, 915; Kening and Medvedev, 917; Yermakov, 931). These lakes contain water so saturated with salts that only forms adapted to the utmost degree to the mineralization of water can make their habitat there. Therefore the plankton of Lake El'ton is limited to only two kinds of flagellates -- Dunaliella salina and Asteromonas gracilis, are typical halibates galobiyonty, not found in waters that are at all distilled. The first form, possibly, explains the characteristic rose-colored hue of the brine. The plankton of Lake Baskunchak has remained unclarified; however, its hydrofauna must bear these same features of extreme barrenness, if it is not to disappear completely.

During the examinations of the above-mentioned lakes, innumerable additional water sources found in connection with the lakes were studied; there are data about the following things in the vicinity of El'ton: the dam at the El'ton Railway Station, the Bol'shaya Smorogda River and the Malen'kaya Smorogda River, the Karantinnaya River, the Lantsukh River, the Khara-zakha River, the Chernavka River (all flow into Lake El'ton), and the fresh water estuary four kilometers northwest of the lake (a water source which is drying up). The pond at the station and the estuary are fresh water bodies. Bol'shaya Smorogda and Malen'kaya Smorogda, the Karantinnaya, the Khara-zakha are rivers with considerable saltiness. Because of

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this it is characteristic that they have a very slow current most of the time, and in their upper reaches form individual pools, in conjunction with which their hydrofauna can be grouped according to definite biotypes. The pond at the station, investigated in the early spring, can be characterized because of the makeup of its zooplankton, as a periodical spring pond with some of the special faunal features of the very southeastern European part of the USSR; there we find: Brachionus quadratus, tridentatus, Hemidiaptomus ignatovi, Cyclops bicuspidatus, Streptocephalus torvicornis, Chirocephalus sp., Lepidurus apus, Leptestheria sp. The fresh-water pond (literally drying up every summer), also examined in the spring, gives a somewhat different picture; in it along with Hemidiaptomus ignatovi, Chirocephalus and Lepidurus apus, there is found among the spring forms Diaptomus amblycodon and in addition to this many Cladocera: Simocephalus exspinosus, Ceriodaphnia reticulata, Alonopsis ambigua, Alona tenuicaudis, A. Rectangula, Alonella excisa, Leydigia acanthocercoides, Pleuroxus aduncus and Chydorus sphaericus.

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The Bol'shaya and Malaya Smorogda, which are water sources with a fluctuating saline content, from their sources to their mouths (0-16.5 degrees Baume), have, of course, a varying plankton makeup; at the mouths where the concentration of salt reaches its maximum, the only plankton found are Artemia salina, Diaptomus salinus, Cyclops strenuus, bisetosus, viridis, Notocra simplex, Walterstoffia blanchardi (Cletocamptus retrogressus) and Gammarus pulex.

The last-mentioned form is found only in the upper and middle reaches of the Bol'shaya Smorogda (when the salinity is not great). The number of species decreases progressively down the river's

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course, but on the other hand forms like Brachionus mulleri, Artemia salina, and Walterstoffia blanchardi reach innumerable proportions. It is important that we mention among the halobions (halobionty) Monostyla lamellata, Pedalion fennicum, Schizopera longicauda var. clandestina. The presence of Eurytemora lacustris in the Malen'kaya Smorogda is characteristic (2.0 degrees Baume).

In the Khara-zakha River (when the salinity is 1 degree Baume), the greatest proportion of halobions is made up of Brachionus mulleri and Walterstoffia blanchardi; only in the pools at the confluence of the river is Artemia salina found. Finally, in the majority of spring specimens (the middle of April) are there found among the plankton of the different ponds the rotifers Notholca striata, N. acuminata, which can be considered as halophytes.

The information about photoplankton of saline streams -- the tributaries of the El'ton -- is insignificant. In the streams of the Bol'shaya and Malen'kaya Smorogday, which have a density of brine 3.5 to 4 degrees and 16.5 degrees Baume there are found Dunaliella salina (Bening and Medvedev, 917); in the Chernavka Rivers which has more fresh-water, the makeup of photoplankton is more varied, depending on the predominance of certain silicates. On the surface of the water ribbons of green intestinal organisms (kishechnitsy) (Enteromorpha), swim in large groups, making the places the habitat of innumerable flies -- Ephydra (Popov, 781).

Water sources in the vicinity of Baskunchak which have been subject to examination, are the following: the Kordonnaya ravine, the well in the Surikov ravine at Bogdo Mountain, the pond in the lower part of the Surikov ravine, the estuary of Shara-bulak, Gor'koye Lake, the Gor'kiy Channel (yerik), the streams and pools around Sharovskiy saltworks and

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finally, the small pond not far from the lake, where the NaCl content is 24.1806 percent, there is found only Artemia salina. In these above mentioned ponds there are found the following: in the Kordonnaya ravine -- Brachionus mulleri (many) and above all a quantity of euglenoids whose coloring takes on the coloring of the water; in the well -- Moina macrocopa (very many) and Cyclops diaphanus; in the pond: Moina macrocopa (many), Cyclops bisetosus and Anuraea cochlearis; in the estuary of Shara-Bulak: Triarthra breviseta and Anuraea cochlearis; Gor'koye Lake (dry remains -- 24.46 grams per liter, sodium chloride -- 12.75 grams per liter) gave rather varied plankton; in it are found Brachionus palaamphiceros, angularis, Schizocerca, Bosmina longirostris, Alona rectangula, Asplancha sieboldi, Pompholyx complanata, Polyarthra, Triarthra, Cyclops vicinus (many) and others; this complex form is a special pond plankton, which, notwithstanding the considerable concentration of salt, does not resemble a halobion or a halophyle in make-up. In comparison to this the Gor'kiy Channel which flows from this lake into Baskunchak (the density of water in the cavity is 13 degrees Ve'), contained in the make-up of its plankton exclusively halobes (galobii) -- Brachionus mulleri (very many), Doaptomus salinus (many), Walterstoffia blanchardi and Nitocra simplex. Finally, the remaining water sources of Baskunchak system, its streams and the pool near Sharovskiy salt works, are stocked with Brachionus mulleri, Artemia salina, Diaptomus asiaticus, Anuraea cochlearis and aculeata. In one of the small ponds not far from Lake Baskunchak, when the NaCl content was 24.18 percent, only Artemia salina was found.

Among the above mentioned fauna the following deserve special mention both for their vast geographical distribution and their ecology -- Diaptomus (Paradiaptomus) asiaticus (a form of central Asiatic origin), for which Lake Baskunchak, quite possibly, is the westernmost limit,

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Diaptomus salinus (Gor'kaya stream), adapted to a definite, not too high degree of salinity, and demonstrating great variability in some of its characteristics depending on the chemical affinity of certain habitats, Hemidiaptomus ignatovi -- also a form of central-Asian fauna. Of the rotifers, the origin of the Caspian form Pterodina clypeata is interesting. In all, 63 forms related to zooplankton (including Euphyllopoda and Harpacticoida) were classified as present in the water sources of El'ton and Baskunchak; on the basis of observations made as to their diffusion in the ponds depending on the chemical affinity, they can be reclassified as haloccenes (galokseny), halophyles and halobions.

The benthos of El'ton and Baskunchak, the rivers flowing into them, and the surrounding small water sources, bear the same special imprint as the plankton and is represented chiefly by halophyles and halobions. As regards the macroscopic forms, the list of those found on the bottom is not very great. According to data published up to this time (Deniv and Medvedev, 917, Yermakov, 931, d'Orchymont, 879), it is limited to the following forms: hirudinea -- Gammarus pulex, mollusks -- Hydrobia ventricosa, Rhynchota -- Corixa hieroglyphica, assimilis, Coleoptera -- Helophorus minutus, orichsoni, Ochthebius laevigatus, Coelambus caspius, fluviventris, enneagrammus, Laccophilus verescens, Graphoderes austriacus, Cybister lateralmarginalis, Gyrinus marinus, Berosus bispinus (spinosus-guttalis), signaticollis, Paracymus aeneus, Philydrus bicolor, bipunctatus, Laccobius minutus, biguttatus. Two-winged of the (khironomidy) -- Orthocladius and Tendipes of the ceratopogonids -- Culicoides, the (kulitsidy) -- Culex modestus, Aedes salinus and dorsalis, Ephydra, Stratomyidae. Information about the remaining forms is given in the chapter on zooplankton. To the halophyles, i.e., the forms preferring salt waters but found also in completely fresh water, can be

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added, according to Bening, the beetles -- Philydrus, Paracymus, Coelambus caspius, the larvae -- Culex, Aedes, Culicoides, to the halibates living exclusively in salt waters -- Hydrobia ventricosa, Ochthobius laevigatus and the larva -- Ephydra.

The following forms are predominant in the water sources described, the individuals reaching a considerable number: Culicoides, Aedes, Ephydra, Corixa assimilis, Ochthebius, Gammarus pulex. The last form cannot be listed among the halophyles; it is found in abundance in the ponds of the Bol'shaya Smorogda and Khara Rivers among the shore vegetation, by this means avoiding the very salty parts. According to the unpublished data of Yermakov, Kranin, and Popova, the poorest benthos are found in the saltiest rivers (the Malaya Smorogda -- 16.5 to 19.0 degrees Baume); in the fresher water the number of benthos per 0.1 square meter is very great -- up to 100,000 Harpacticoida, 13,000 (chironomidy), 11,000 Ceratopogonidae and so on. As regards Lake El'ton its whole population consists of two forms; the benthos, at least the macroscopic, do not appear. Related information for Baskunchak does not exist.

Turning, finally, to the microbiology of Lakes El'ton and Baskunchak, we find that no published information exists about the microbiological examination of Lake Baskunchak. In the case of El'ton, V. P. Radyshchev did a rather detailed examination of the lake in 1927-1929 to determine the cause of the rose-colored hue of the brine. When a flask with brine stands in the laboratory, a sediment is deposited on the bottom of the flask. Deposits from samples with rose-colored brine have a dark rose color or a red with violet shading; the deposits from samples with uncolored brine (winter) have a dirty white color. Microscopic examination of the deposits showed them to consist of algae cells, for the most part deformed and bearing the remains of green pigment,

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particles of completely destroyed cells, and some forms of bacteria, chiefly diplococcus. When the brine is siphoned off from the deposit, after several months another deposit forms from the same brine, and when the procedure is repeated the same occurs again several times.

The deposits under the layer of brine are preserved for an indefinite period of time, during which the bacteria in them remain alive, and the color of the deposit does not change. The author emphasizes that in the samples of rose-colored brine taken in the summer, the deposits examined consisted wholly of bacteria, predominantly diplococci. All samples of colored brine were taken from the salted crust, in this way avoiding having dirt fall into it. This continuous formation of red deposits in the brine, essentially of bacteria cultures, leads to the supposition that the red hue of brine from El'ton is of bacteriological origin. Cultures of bacteria were made on agar prepared from natural filtered brine, diluted nine to one. Within three months after the culture was started, by the introduction of infection into the warm, not yet congealed agar, tiny red spots were noticed in various places in the dense part of the agar jelly -- colonies which turned out to be pure or almost pure cultures of diplococci, such as are found in great quantity in the red deposits which settle out from the brine. Their slow growth under experimental conditions and small size are characteristic for these colonies.

The difference in color of the deposit settling out of the brine, is explained by Radishchev as dependent on the time of year. Samples of brine taken in February 1 29, were at first uncolored. Their dirty white deposit consisted chiefly of flagellate forms, having, almost exclusively, green pigmentation. The algae Nacicula and others were rarely found. On a line with the flagellates there was a considerable number

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of bacteria, but comparatively less than of flagellates. One sample of this uncolored winter brine was left under diffused light in a small flask with a cotton stopper. After two months no change was noticeable. Placed in the sun in April, the culture began to turn rose-colored within two weeks, and inside of two months the rose hue was intense. Another sample of brine left in diffuse light turned rose-colored considerably later. The brine, filtered through a fine filter, under conditions of lighting and temperature resembling those of the second portion, turned rose-colored just like the second portion. The development of Dunaliella was not observed during the whole time of the tests. In addition to the tests concerned with determining the reason for the color of the brine, the author made several observations related to the characteristic biochemical processes taking place in brine during its continued standing. The processes of change and decomposition of organic matter take place in brine extremely slowly. The dull turbidity and color of the brine do not disappear for more than a year under standing, although towards the end its transparency increases.

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Lake Botkul'

Lake Botkul', shown on the map of VTO (Military Topographical Division) 1:420,000 as the salty sediment of waste from Botkul', lies at a latitude of 46 degrees, 43 minutes, 30 seconds and a longitude of 46 degrees, 41 minutes. Exact information is not available as to the present condition of the lake with respect to the amount of water it holds and its contours. There is the information of A. K. (605) that the area of Botkul' is 65.9 square kilometers. During the time of G. F. Fedchenko's investigation it had a considerable water supply, never dried up, and was filled chiefly in the springtime from the side lying farther east than the khaki salt sediments. On the VTO map published in 1918, Lake Botkul' (represented as salty sediment) has an irregular lobe-shape with the length running from west to east. The shores of the lake are elevated with a wide beach under them in the form of an alluvial bank, on which there emerges in places a crumbly layer of salt formed annually by the evaporation of brine, not more then 0.5 centimeters thick and having a bitter salt taste. A sample of water (Fedchenko, 1597-a) taken 105 meters from the shore had a bitter stinging taste with a strong odor of hydrogen sulphide. The temperature of the water on 15 July 1063 was 19 degrees, the specific gravity at 15.5 degrees -- 1.100021. The dry remainder, before evaporation at 120 degrees, was 12.939 percent and consisted of 6.867 percent chlorine, 0.8370 percent sulphuric acid, 0.2024 percent calcium, 1.0981 percent magnesium. In addition to this the water contained sodium, traces of potassium, bromine, iron, and hydrogen sulphide. The bottom of the lake is mud-clay and does not have layers of salt.

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OF THE LOWER VOLGA

(in Hectares)

Including:

Out of These:			Total Swamps type not established (in Hectares)	Percent of Swampiness
Upland Swamps (in Hectares)	Transitional Swamps (in Hectares)	Bottomland Swamps (in Hectares)		

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NOTE:

In the column under the title "River Basins" the parenthesis contains the name of a river, whose tributary is the given river. No parenthesis indicates that the given river is a tributary of the Volga.

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		61, 62, 63, 64, 65 SECRET	25-a, 26-a, 37-a 9k-S, 9k-b
Page 375	Including: (a) right bank, less basins number 8-11	Ul'yanovskiy Okrug 45, 60, 61, 62, 63, 64, 65	Ul'yanovskiy Okrug 25-a
	(b) left bank, less basins number 12-15		Ul'yanovskiy Okrug 26-a, 37-a, 9k-S, 9k-b
8.	B. Sul'cha (B Cheremshan)	Tatarskaya ASSR 78, 79, 79-a, 81, 81-a	
9.	Chemerlik (Cheremshan)	Tatarskaya ASSR 86	
10.	M. Cheremshan (B. Cheremshan) Including: (a) right bank	Tatarskaya ASSR 76, 77, 80, 82, 83, 84, 89	Ul'yanovskiy Okrug 35-a, 36-a
	(b) left bank	Ul'yanovskiy Okrug 35, 36 Tatarskaya ASSR 85	
11.	Tiya (B. Cheremshan	Ul'yanovskiy Okrug 46	Ul'yanovskiy Okrug 46-S
13.	Karmala (B. Cheremshan)	Ul'yanovskiy Okrug 37	Ul'yanovskiy Okrug 37-a
Page 376 15.	Tasolka (B. Cheremshan)		Samarskiy Okrug 24
19.	Kondurcha (Sok)		Ul'yanovskiy Okrug 9k-a
20.	Borovka (Samara)	Samarskiy Okrug 3	
28.	Kinel' (Samara), less basin number 29-37	Samarskiy Okrug 5	
	Including: (a) right bank, less basins number 29-34	Samarskiy Okrug 5	

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30.	Kochegay (Kinel')	SECRET	Buguruslan Okrug 26, 27, 28, 29
	Including: (a) right bank		Buguruslan Okrug 29
	(b) left bank		Buguruslan Okrug 26, 27, 28
49.	Usa, less basins number 50, 51	Syzranskiy Okrug 64, 65, 66, 67, 68, 77, 78, 79, 80, 90	Syzranskiy Okrug 64-a, 80-a
	Including: (a) right bank, less basin number 50	Syzranskiy Okrug 77, 78, 90	Syzranskiy Okrug 64-a
	(b) left bank, less basin number 51	Syzranskiy Okrug 64, 65, 66, 67, 68, 79, 80	Syzranskiy Okrug 80-a
50.	Timerka (Usa)	Syzranskiy Okrug 87, 88, 89, 91, 92, 93	Syzranskiy Okrug 87-a, 89-a
51.	Tukshum (Usa)	Syzranskiy Okrug	Syzranskiy Okrug 64-a
52.	Syzran, less basins number 53-55		
	Including: (a) right bank, less basins number 53-54	Syzranskiy Okrug 63, 83, 84, 94	Syzranskiy Okrug 63-a, 63-b, 81-b, 84-a, 84-b, 94-a Kuznetskiy Okrug 52-a, 46-a
	(b) left bank, less basin number 55	Syzranskiy Okrug 82, 95, 96, 97, 98, 99	Syzranskiy Okrug 63-a, 63-a, 63-d, 63-g, 63-b, 70-a, 71-a, 73-a, 74-b, 74-a, 74-b, 81-a, 81-a, 82-a, 82-b, 83-a, 94-a, 94-b, 99-a, 99-b.

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53.	Bekshanka (Syzran)	Syzranskiy Okrug 81	Syzranskiy Okrug 23-a, 24-a, 25-b, 26-a
55.	Tomashevka (Syzran)	Syzranskiy Okrug 73, 74, 75, 85, 86	Syzranskiy Okrug 75-a
59.	Kurdyum	Atkarskiy Okrug 2	
	Basins of other Rivers and non-draining areas		
	TOTAL		

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BASIC DATA ON THE SWAMPS OF THE LOWER VOLGA

Number of River Basins in sequence	River Basins	Basin Areas, (in thousands of hectares)	Number of Swamps as per Primary source (People's Commissariat of Health RSFSR)	Number of Additional Swamps, accounted for by other data.	Area of Swamps (in Hectares) Total Area of Swamps (in Hectares)	Area of Swamps of estuary-shed type, (in Hectares)	Including: Out of There Upland Swamps (in Hectares)	Transitional Swamps (in Hectares)
1.	Volga, less basins number 2-60 Including: (a) right bank, less basins number 49-61 (b) Left bank, less basins number 2-48		Samarskiy Okrug, 2-4 Ul'yanovskiy Okrug, 29, 30, 31, 32, 33. Tatarskiy Okrug, 73	Samarskiy Okrug 2-a, 2-S Samarskiy Okrug, 4-S, 4-1				
2.	Bezdna		Tatarskaya ASSR 75, 76					
3.	Utka		Ul'yanovskiy Okrug 1, 2, 3					
4.	Mayna		Ul'yanovskiy Okrug 17, 18, 19, 20	Ul'yanovskiy Okrug 20-a, 20-b				
5.	Uren'		Ul'yanovskiy Okrug 36, 43					
6.	Kamayur		Ul'yanovskiy Okrug 44, 59					
7.	B. Cheremshan, less basins number 8-15		Ul'yanovskiy Okrug 45, 60,	Ul'yanovskiy Okrug				

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DATA ON THE SWAMPS OF THE LOWER VOLGA

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Area of Swamps (in Hectares)

Total Area of Swamps (in Hectares)	Area of Swamps of established type, (in Hectares)	Including: Out of These: Upland Swamps (in Hectares)	Transitional Swamps (in Hectares)	Bottomland Swamps (in Hectares)	Total Swamps type not established (in Hectares)	Percent of Swampiness

Pages 374, 375, 376, 377

NOTE:

In the column under the title "River Basins" the parenthesis contains the name of a river, whose tributary is the given river. No parenthesis indicates that the given river is a tributary of the Volga.

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page 374	53.	Bekshanka (Syzran)	Syzranskiy Okrug 81	Syzranskiy Okrug 2-a, 21-a, 25-b, 26-a
	55.	Tomashevka (Syzran)	Syzranskiy Okrug 73, 74, 75, 85, 86	Syzranskiy Okrug 75-a
	59.	Kurdyum	Atkarskiy Okrug 2	
		Basins of other Rivers and non-draining areas		
		TOTAL		

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30.	Mochegay (Kinel')	SECRET	Buguruslan Okrug 26, 27, 28, 29
	Including: (a) right bank		Buguruslan Okrug 29
	(b) left bank		Buguruslan Okrug 26, 27, 28
49.	Usa, less basins number 50, 51	Syzranskiy Okrug 64, 65, 66, 67, 68, 77, 78, 79, 80, 90	Syzranskiy Okrug 64-a, 80-a
	Including: (a) right bank, less basin number 50	Syzranskiy Okrug 77, 78, 90	Syzranskiy Okrug 64-a
	(b) left bank, less basin number 51	Syzranskiy Okrug 64, 65, 66, 67, 68, 79, 80	Syzranskiy Okrug 80-a
50.	Timerka (Usa)	Syzranskiy Okrug 87, 88, 89, 91, 92, 93	Syzranskiy Okrug 87-a, 89-a
51.	Tukshum (Usa)	Syzranskiy Okrug	Syzranskiy Okrug 64-a
52.	Syzran, less basins number 53-55		
	Including: (a) right bank, less basins number 53-54	Syzranskiy Okrug 63, 83, 84, 94	Syzranskiy Okrug 63-a, 63-b, 81-b, 84-a, 84-b, 94-a Kuznetskiy Okrug 52-a, 46-a
	(b) left bank, less basin number 55	Syzranskiy Okrug 82, 95, 96, 97, 98, 99	Syzranskiy Okrug 63-a, 63-s, 63-d, 63-g, 63-b, 70-a, 71-a, 73-s, 74-b, 74-a, 74-b, 81-s, 81-s, 82-a, 82-b, 83-a, 94-a, 94-b, 99-a, 99-b.

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ADDITIONAL LIST OF SWAMPS OF THE LOWER VOLGA
(TO PUBLICATION "PEAT RESOURCES OF THE RSFSR")

Numbers as on Map	Name of Swamp [1] /Explanatory note at bottom of last page/	Distance from nearest city, railroad station or village (in kilometers)	Swamp Area (as surveyed in Hectares) / Peat Body Area (in Hectares)	Mean Depth (in meters) / Maximum Depth (in meters)	1. Type of Swamp 2. Vegetation Schedule	D=Degree of decomposition; A=Ash content; C= Thermal capacity (in calories) W=Moisture etc.	Swamps investigated	Swamp utilized as	1. Water intake, and 2. Notes
				b. U L ' Y A N O V S K I Y O K R U G					
20a	On Timerka River, S. Khmelevka, Imz	Ul'yanovsk-92 S. Bryandino-22 S. Mikhaylovka-25	37.6 / 6.5	0.67 / -	1. Lowland 2. Alder, Willow, Sedge	Well decomposed W-ample	Statistical Study. 1929	Hay making	1. Timerka River 2. Not drained.
20b	Vigamur, S. Khmelevka	Ul'yanovsk-92 S. Bryandino-35 S. Mikaylovka-0.2	26.0 / 5.5	1.2 / 1.6	1. Lowland 2. Willow and Sedge	Well decomposed W-ample	Statistical Study 1929	Hay making	1Rivers Timerka and Khmelevka 2 not drained
25a	Khura-Sirik	Sadovan Stn.-3 Tannery Dubitel' 3.5	- / 150.0	- / 2.3	1. Lowland 2. Sedge and Others	Mineral interlayer up to 1 meter.	Inspection route, 1931	Not utilized	2. not drained

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26a	Khyrkyz	Sadovan Stn-0.4	- / 15.0	- / 2.3	1. Lowland 2. Grass-ligneous		Inspection route 1931	Not utilized	2. Not drained
35a	Cheremshanskoye, Ipkh; Blocks 5-6, 13-14	Melekes - 40 Yakushka Stn-35 S. Sakhga - 4.5	- / 65.0	1.0 / 2.2	1. Lowland	Well decomposed	Statistical study 1929	Not utilized	1. M. Cheremshan(1500 meters away) 2. Not drained
36a	Cheremshanskoye, Ipkh; 5-6, 13-14 Blocks	Melekes - 40 Yakushka Stn- 35 S. Sakhga - 4.5	- / 27.0	0.6 / 2.5	1. Lowland	Well decomposed	Statistical study 1929	Not utilized	1. M.Cheremshan (1500 meters away) 2. Not drained.

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37a	Kas'ma	S. Zemuratke -2 S. Maksimkino( ) 2	177 146	1.94 n.o	1. Lowland 2. Sedge, Reed	P=60-80 percent A=92 percent A mean= 2.1 percent; Q^F = 2818-2910 Q^Fmean= 2959	SKIT 1931	Not utilized	1. R. Cheremshan (1500 meters away) 2. Not drained
37b	Mokhovoye, Lmz; S. Staraya Karmala	Ul'yanovsk - 165 Sadovan Stn- 10 S. Karmala- 2	347 166	2.26 5.20	1. Lowland 2. Sedge, Reed	Light-brown peat, P=70-85 percent; A=10.1-39.0 percent; A mean= 18.1 percent; Q^F=3161		As meadow	1. Rivers Karmala and Cheremshan. 2. Not drained
46a	Trekhsvyatskoe, Glf. (Tiinsk Forestry Division)	Ul'yanovsk- Melekes Stn- S. Briga-dirovka- 2	15.1 2.2	1.1 1.6	1. Lowland	P=low W=ample, medium Cohesion, no interlayers	Statistical study 1929	Hay making	1. River Tiya (150 meters away) 2. Not drained

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46s	Shirokoye, s. Shirokoye, Lmz.	Ul'yanovsk -9k Melekes - 16 Tiinsk - 2	31.4 / 6.7	1.8 / 1.0	1. Lowland 2. Alder, Willow, Rush Sedge	D=redium W=ample, medium cohesion, mineral interlayers with Shellrock at 1.5 meter depth	Statistical study 1929	Hay making-	Not drained
Page 380 - 381									
9ha	Kosogor, S. Teneevo	Ul'yanovsk-181 Pogruznaya Stn-15 Teneeva Stn-0.5	- / 5.1	0.9 / 1.0	1. Lowland	D=good, l w cohesion, argillaceous interlayer at 1 meter depth	Statistical Study 1929	Not utilized	1. River Kondurc a (1 kilometer away) 2. Not drained
9hb	Yelcshnik, S. Teneevo	Ul'yanovsk-181 Pogruznaya Stn-15 Teneeva Stn-0.5	- / 9.6	0.7 / 1.5	1. Lowland	D=low, brown color, Argillaceous interlayer at 1.5 meter depth	Statistical Study 1929	Not utilized	1. River Kondurcha (close by) 2. Not drained
9hs	Chernoye Lake, S Teneevo	Pogruznaya Stn-15 Ul'yanovsk- 181	- / 7.5	0.75 / 1.0	1. Lowland	D=dark- rown color, with argillaceous interlayers at 1.5 meter depth. W= very low	Statistical Study 1929	Not utilized	1. River Kondurcha 2. Not drained

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b. KUZNETSKIY OKRUG

46a	Mokhovoye, Lpkh	Kamadeyskaya Dacha -25 Yevlashevo Stn-7	6.5 / 6.3	2.25 / 2.05	1. Transitional 2. Hypnoid-sphagnum mosses, pine sedge, reed	D= low	Saratov [illegible] reconnaissance 1927	No data	Not drained but drainage possible.
52a	Mokhovoye, Komarovskaya Dacha, Lpkh.	Komarovskaya Dacha, Kuznetskiy Lpkh. - 58 Yevlashevo Stn-8; S. Maloye Gruevo - 7, in the 57 block of Kuzn. Lpkh.	6.7 / 5.2	1.55 / 3.0	1. Transitional 2. Fine, sedge, reed, hypnoid, sphagnum, with forest litter	No data	Krav ZU statistical count 1951	no data	Not drained but drainage possible

b. SYZRANSKIY OKRUG

23a	Ingovaye, S. Russkaya Bekshanka	Alongside settlement, to the north	5.0 / 4.5	1.65 / 4.0	1. Lowland 2. Sedge, reed.	D=good	Statistical study 192[illegible]	As Pasture	Not drained
24a	Pigor'ye, S. Russkaya Bekshanka	to the west from Russkaya Bekshanka	1.9 / 1.2	1.25 / 2.5	1. Low land 2. Sedge, reed	D=good	Statistical Study 1928	As pasture	Not drained

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25a	Ol'khovskoye, S. Novaya Bekshanka	Northeast of Novaya Bekshanka, along river Peayvyannaya - 1	2.0 / 1.0	1.2 / 2.0	1. Lowland 2. Sedge, reed, Alder	Somewhat silty	Inspection route 1931	Hay making and undergrowth	Drainage can be easily accomplished
63a	Moskvicheva Polyana, S. Vasilyevka, Glf. and Lnz.	Matyushino-3	139.0 / 137.0	1.62 / 3.0	1. Lowland-transitional 2. Sedge, reed, willow, hypnoid-sphagnum mosses	D=good	Statistical Study	Hay Harvesting	Drainage can be easily accomplished
26a	Nikulinskoye, Glf.	S. Surskaoye versh. - 4 Remyantsev factories - 20	- / 16.01	1.9 / 3.5	1. Upland	D=good A=3.36 percent Q = 3.32	Detail inspection 1927	No data	Drained
63b	Barskiy rodnik (spring) S. Zelenkovsk	Zagarinsk Winery (along the brook)- 2.5	2.0 / 1.1	1.2 / 2.1	1. Lowland 2. Open, with Alder	Peat with sedge-reed characteristic	Detail Inspection 1927	Hay making and undergrowth	Not drained
63v	Mazy, S. Zhivaykino	Zhivaikin Stn- 2	10.2 / 5.6	2.1 / 1.0	1. Lowland	D=medium peat with sedge characteristic	Statistical study 1928	Pasture	Not drained

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63f	Balanda, Ss Pravda, Zhivaykino	Baryshi Stn-(on left bank of river Syzran)-25 S Pravda-0.5	16 1.1	1.3 2.8	1. Lowland 2. Willow, Alder hypnoid asses	Peat of the sedge-reed type, with admixture of lignin.	Inspection route 1931	Meadow	Dry	
63d	Podmazok, S. Zhivaykino	S. Shivaykino-3	3.0 1.8	0.8 1.5	1. Lowland 2. Alder quagmire	D=medium peat of sedge-reed alder type. W=medium	Inspection route 1931	Undergrowth	Drainage can be easily accomplished	
63m	Podmazok (Continuation), S. Zhivaikino	S. Zhivaikino (on the right bank of river Syzran) - 2	2.0 1.2	0.8 1.5	1. Lowland	D=medium peat of the sedge-reed type, with admixture of silt. W= medium	Inspection route 1931	Undergrowth	Drainage can be easily accomplished	
63e	Syzranskoye, S. Karmaleyka	S. Karmaleyka-2.5	- 7.4	1.5 3.5	1. Lowland 2. Sedge	D=medium gr= 307%	Detail Inspection 1927	No data	drained	
70a	Lopaty, S. Zhedrino	Teplovsk Winery - 12 Flooded bottom land	22.8 16.8	1.7 3.0	1. Lowland 2. Reed, sedge hypnoid, willow, some alder	Peat of sedge-reed type	Statistical study 1931	Hay harvesting	Not drained but can easily be drained	

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6ha	Klin	Along river Ul, near S. Coryushka	- / 3.0	3.5 / 4.0	1. Lowland	I=Proud, color dark-brown, with mineral interlayers and admixtures, peat of the sedge type	Statistical study 1931	Meadows	Not drained
6hs	Fed'kinskiye Kusty	Near S. Fed'kino	10 / 8	3.33 / 4	1. Lowland	I=medium, with silt admixture, hydrogen sulfide odor, color, dark chestnut, Peat of sedge type	Statistical study 1931	Not convenient	Not drained
71a	Metyuninskoye	S. Prizyv, between the plant and the settlement, on right bank of Temryazan'	1.5 / 3.2	2.42 / 3.2	1. Lowland 2. Serge, reeds, hypnoid and some alder	I=medium M=medium	Statistical study 1931	Pasture and Hay making	Drainage can easily be accomplished
73a	Serol, Russkaya Naleyka Stn Temryazan'		16.0 / 13.8	1.9 / 3.5	1. Lowland 2. Grass cover: sedge, reed hypnoid moss	I=medium slightly silted. 50 percent of area covered with mixed forest	Statistical study 1931	Hay making and forest	Almost dry can easily be drained

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73b	Cryaznay Chasha, Clf.	Russkaya Temryazan' Stn-10	5.2 / 3.5	1.6 / 3.0	1. Lowland 2. Sedge, reed, with hypnoid covering	Ligneous vegetation: birch, aspen; taprines present	Statistical study 1931	Clf	Can easily be drained
74a	Vasil'yevskaya Polyana, S. Vasil'yevka	S. Matyunino-2	16.0 / 5.0	1.3 / 2.5	1. Lowland 2. Large Sedge, hypnoid	Peat (silted)	Statistical study	Meadow	Drainage can be accomplished
74b	Iesnyye Zyamintsy, Clf. and Lmz.	Vasil'yevka-0.5	6.2 / 2.5	0.8 / 1.5	1. Lowland 2. Reed, sedge, small birch alder, willow, hypnoid cover.		Statistical study	Forest and underprowth	Drainage can be accomplished
75a	Uzilovo, Clf.	Racheyka Stn. 2 to northeast	3.5 / 3.0	2.0 / 3.9	1. Upland	Top peat is of sphagnum type, bottom layers of sedge-reed type, with interlayers of silt and water	Statistical study 1929	Clf.	Not drained

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8oa	Shigonskiye Kobly	Sigon St. to the southeast-5, Beloklyuch to the northeast - 2	35.0 3.0		1.4 2.3	1. Lowland	Peat of the sedge-reed type, with admixture of sand and silt.	Inspection of 1931	Not convenient	Drainage is difficult
8/a	Zelenkovskoye	Zagarinsk Winery to northeast-1	1.0 0.9		1.0 2.1	1. Lowland 2. Sedge-reed with willow undergrowth	Depo d Medium	Statistical study	Meadow and undergrowth	Can easily be drained
8/b	Maza II, S. Proletarskoye	S. Prolet on right bank of River Syzran - 0.5 Teplovka to southeast - 15	15.2 11.3		1.86 2.20	1. Lowland 2. Sedge, reed, much hypnoid, from 2.5 meter depth admixture of lignin and mineral residue		Statistical study	Hay-making and undergrowth	Can easily be drained
8/s	Mokhovoye, S. Shemurshi	Shemurshi to the east on road - 5	7.6 3.0		0.75 1.0	1. Lowland 2. Hypnoid moss cover	Formerly a water-retaining pond	Statistical study Xray ZU	Not Utilized	Abundant water, difficult to drain

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82a	Plant Zimnitsa of Leso-matyuninskiy Kolkhoz	Winery on left bank of river Temryazan' - 0.1	8.5 / 7.8	1.2 / 3.0	1. Lowland 2. Sedge, reed, hypnoid.	Ligneous vegetation: willow, alder, s all birch.	Statis-tical study	Pasture	utilized for 8 - 10 years
82b	Matyuninskiye Truck Gardens	Winery on right bank of river Temryazan'- 0.4	4.2 / 3.2	1.94 / 3.0	1. Lowland 2. Sedge-reed with hypnoid cover.	Medium Medium Admixture of alder.	Statis-tical study	Pasture and hay-making	Not drained, can easily be drained
83a	Litvinskoye Mokhovoye	S. Lat-Shemur-shi to the north - 2	8.5 / 3.1	0.68 / 1.0	1. Lowland 2. Hypnoid and large sedge	Sample	Statis-tical study	Hay harvesting	Draining is difficult
84a	Biya-Marki, S. Teplovka	S. Teplovka to The southwest-2; S. Kaneval M - 10	28.2 / 18.3 19.0 / 13.8	1.94 / 4.2 2.54 / 4.59	1. Lowland 2. Sedge, reed	D=60-70 percent A=7.5 percent QF=2315-2778 No mineral interlayers	Detail Inspec-tion SKIT 1931	Not uti-lized	Drainage possible
84b	Sanaevo, Inz. and Glf.	S. Teplovka to southeast on left bank of river Syzran-2.5	6.4 / 4.5	2.62 / 4.5	1. Lowland 2. Sedge, reed	D=60-70 percent A=10 percent QF=2867 No mineral interlayers	Detail Inspec-tion SKIT 1931	Not utilized	Drainage possible

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87a	Chekalinskiye Luga (Meadows), S. Chekalino	Syzran' city - 15	230/30		1.6/3.0	1. Lowland 2. Sedge, reed, alder	Peat with silt admixture, most of swamp covered with mineral alluvia	Statistical study Kray ZU 1931	Undergrowth; not convenient	Not drained
89a	Bol'shoya Berezka, S. Raduzhnoye	S. Raduzhnoye to the east- 0.5	75.0/7.0		1.5/3.6	1. Lowland 2. Sedge, reed, alder	Interlayer of shell rock at 1.5 meter depth	Statistical study Kray ZU 1931	Haz., hay making	Not drained
91a	Gorelyye Kochki, S. Teplovka	S. Teplovka to the south - 3	11.0/7.0		1.56/3.0	1. Lowland 2. Sedge-reed with admixture of hypnoid	Peat of the sedge-reed type, with admixture of lignin at 0.4-0.5 meter depth, and interlayers of silt.	Statistical study 1931	Haz., hay making	Not drained
91b	Trafimova Polyana1, S. Peski	Teplovka to the northwest- 6; S. Colovino- 2.5; Karaninsk Winery- 9	5.8/3.5		1.76/3.0	1. Lowland 2. Sedge, horse-tail, hypnoid, small birch, alder	Peat of the sedge-reed type	Statistical study	Hay harvesting undergrowth and pasture	Not drained

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98s	Trofimora Polyana II, S. Peski	Teplovka - 10, S. Golovkino to the northwest-4	2.8/2.0	1.4/2.0	1. Lowland 2. Sedge, reed, birch	Peat of the sedge-reed type	Statistical study	Hay harvesting and pasture	Surface is dry
99a	Zaborovskoye, S. Zaborovki.	In Settlement Zaborovki	4.0/2.5	1.6/2.7	1. Lowland 2. Sedge, reed, alder		Statistical study	Hay making	Not drained
99b	Tornoye, Clf.	Railroad siding Samayka to the north - 0.5	8/2	1.0/1.75	1. Lowland 2. Sedge	D=medium		Clf	Not drained

b. BUGURUSLANSKIY RAYON

25	Za Sadami /Beyond the Orchards/	Buguruslan beyond the river Bol'shaya Kinel', near Lake Yelanskoye	-/5.0	0.5/-	1. Lowland 2. Grasses, with admixture of lipneous growth	D=60 percent A=18 percent GF=2977 Argillaceous subsoil	Statistical study 1931	Utilized	Dry

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26	Novaya Krasnoyarka, S. Novaya Krasnoyarka	Near S. Novaya Krasnoyarka	- / 5.0	0.53 / -	1. Lowland	Mineral alluvia= 1.18 percent	Statistical study 1931	utilized Dry
27	Kochkovatoye, S. Krasnoyarka	Krasnoyarsk Mill on right bank of river Pol'shoy Kinel' - 1.5	- / 5.0	0.37 / -	1. Lowland	Mineral Alluvia= 0.23 percent	Statistical study 1931	utilized Dry
28	Krasnoyarskoye, S. Krasnoyarka	Mill on right bank of river Pol'shoy Kinel' - 2.5	- / 5.0	0.42 / -	1. Lowland	Mineral Alluvia= 0.2 percent	Statistical study 1931	Utilized Dry
29a	Klyuchevskoye	Near Klyuchevka Stn.	- / 30.0	0.[illegible] / 1.10	1. Lowland	Mineral Alluvia= 0.2 percent	Statistical study 1931	Utilized Dry

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b. SAMARSKIY OKRUG

2a	Zasheyevo, S. Rozhdenstvenskoye	Samara - 2	- / 3.3	2.13 / -	1. Lowland	
2b	Musorskoye S. MUSORKA	S. Musorka to the east	- / 54.6	2.13 / -	1. Lowland	Statistical study
2s	Pol'shoy Most, S. Rozhdenstvenskoye	Samara - 2	- / 3.3	2.13 / -	1. Lowland	
4s	Lipyagi I	At Lipyagi Stn.	- / 2.1	2.13 / -	1. Lowland	
4b	Lipyagi II	In Lipyagskiy Sovkhoz	- / 1.1	2.13 / -	1. Lowland	

CHAPAYEVSKIY RAYON

4a	Maytuga	At Maytuga Stn.	- / 3.3	2.13 / -	1. lowland	

(1) NOTE: With the name of the swamp is given the name of the settlement (S.) on the grounds of which it is located, also whether it is a part of the state Forest Reserve (Glf.), Timber Management (Lpkh.), or Forests of only local significance (Lmz.).

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THE SALT LAKES ON THE RIGHT BANK OF THE VOLGA

Like the water reservoirs on the left bank, the lakes on the right bank lie in hollows between mounds. Since the mounds lie perpendicular to the river bed, the fresh water can flow freely into the ravines between the mounds, forming "il'men's." Parts of the "ilmen's" split off by the irregularities of the soil from the main part, and lying so high that no lift in the fresh water level can reach them, constitute the salt lakes. A ring of mineral-containing lakes surround the fresh water delta of the Volga. A part of the salt lakes on the right bank lie in direct proximity to the main Volga bed. As an example of the lakes of this rayon the following may be cited as investigated by the expedition of the Academy of Sciences, USSR.

Lake Tinaki (46 degrees, 22 minutes, 30 seconds north latitude and 47 degrees, 50 minutes east longitude) is located 4 kilometers from the Volga landing known as Kalmytskiy Bazar [The Kalmyk Mart], not far from Astrakhan. The lake is 1.3 kilometers long, 260 meters wide, with an area of 26 hectares. The layer of natural brine runs at the depth of 10 centimeters. Under it is a bed of salt, consisting of 2 layers: the upper one is 6-7 centimeters thick, the lower one (darker in color) is 3 centimeters thick. Underneath the latter is a layer of silt, 15 centimeters thick, which is a pliable black mass having a slight odor of hydrogen sulfide. In the silt were discovered individual nests of astrakanite (a variety of bloedite). Under the silt, there is clay. To the southeast of the lake, in the direction of Nikolaevskoye Station, there are several salt marshes, from 0.5 to 2 kilometers long. The salt marshes are usually covered with sodium chloride efflorescences, lying on top of a 3-5 centimeter layer of grayish silt, underneath which there is clay.

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Three mounds to the north from Lake Tinaki, there is the salt lake Karantinnoye, 3 kilometers long and 300 meters wide. Under the annual layer of salt /formed by the evaporation of brine/ there is a small amount of natural brine. The lake is in its drying out period, and is in the process of becoming a salt marsh.

In accordance with the data of the expedition by the Academy of Sciences, the analysis of the natural brine, made by Professor Sokolov in 1920, is presented in table form on page 360 of the original.

Additionally, the right bank lakes; Large Basinskoye, Little Basinskoye, and Malinovskoye, are of great interest since they contain sodium chloride as well as epsomite and astrakanite.

The Large Basinskoye and Little Basinskoye lakes lie 4 kilometers to the south of Basa Station. Large Basinskoye lake (46 degrees, 5 minutes, north latitude, and 47 degrees, 5 minutes east longitude) has an area of 67 hectares, while Little Basinskoye lake has an area of 53 hectares. The thickness of the sodium chloride layer of the later is 5 centimeters. Under this there is a 20 centimeter layer of natural brine which in turn rests upon silt. No astrakanite was found in the crosscut. The annual layer of salt is very pure. The analysis of a lifted 7 centimeter layer of hard salts shows a thin formation of epsomite at the bottom surface; under the annual layer of salt, at its contact with the silt and natural brine, are found dark monoclynical crystals of astrakanite. There is a little natural brine under the annual layer of salt and under the brine there is silt.

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Lake	Specific Gravity	Per 100 Parts of Solution by Weight				Total Salts
		Na Cl	$Mg Cl_2$	$Mg SO_4$	K Cl	
Karantinnoye						
Tinaki						
Same (by Sokolov)						

Lake Malinovskoye (46 degrees, 8 minutes, 30 seconds north latitude; 47 degrees, 1minute east longitude), with an area of 30 hectares, lies to the north of Rasa Station. An elongated salt marsh adjoins it from the east. On the lake proper, there is a thin layer of natural brine. The salt formation is 20 inches thick with clearly visible laminations. Structurally, the formations of Lake Malinovskoye are as follows: sodium chloride, next below, astrakanite and over-grown crystals of magnesium sulfate in the natural brine. A more detailed analysis of these magnesium sulfate crystals identifies them as being of the heptahydrate variety. Composition of the brine from the two Basinskoye lakes and from Lake Malinovskoye, as per analysis made in 1930, is as shown in the table below:

Lake	Specific Gravity	Per 100 Parts of Solution by Weight				Total Salts
		Na Cl	$Mg Cl_2$	$Mg SO_4$	K Cl	
Large Basinskoye (Brine under Saline Mass)						
Little Basinskoye (Brine under Saline Mass)						
Malinovskoye (Brine on Surface)						
Malinovskoye (Brine under Saline Mass)						

Subsequent research by the expedition discovered the following

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structural strata. In the above four cases, after the annual salt layer (from 3 to 8 centimeters thick), covered in some of them (as in Lake Malinovskoye) by crystals of epsomite ($MgSO_4 \cdot 7H_2O$), follow, through a thin interlayer of depositions, the accumulated salt layers of previous years (from 0.5 to 6 centimeters thick), separated by interlayers of silt, usually 1-2 centimeters thick. The silt sometimes contains crystals of magnesium salts of sulfuric acid, mainly epsomite. Following the series of superimposed layers, attaining in some lakes a thickness of one meter, there is an interlayer of mud, from 5 to 15 centimeters thick, then a well crystallized stratum of sodium chloride, known as garnet, after which (as in the Little Baskinskoye Lake) follow strata of astrakanite ($MgSO_4 \cdot Na_2SO_4 \cdot 4H_2O$) with epsomite ($MgSO_4 \cdot 7H_2O$). Then, again, an interlayer of mud, comes deep-well salt, which in some lakes (as in Large Baskinskoye lake) is pure sodium chloride, in others (as in Little Baskinskoye) is astrakanite.

Information is also available on lakes Biryuch'ye and Seydin.

Lake Biryuch'ye (Emkete) lies at 48 degrees, 21.5 minutes north latitude, and 46 degrees, 56 minutes east longitude, 40 miles north of Astrakhan', 1 kilometer from the right bank of the Volga. When investigated by G. P. Fedchenko (1597-a), it was 300 meters long, and 120 meters wide. Its shape was oval, the elongation running southward. The lake lies in a hollow having a sudden dip. The shores are rather steep, with small hard sand beaches, 2-4 meters wide. The lake runs dry in the summer. Fedchenko visited the lake on 31 July 1863, and discovered an annual salt layer from 1.25 to 7.5 centimeters thick. Natural brine was covering the annual layer to a thickness of 9-13 centimeters. Under the annual layer, which was rather friable salt, was a layer of blackish silt, within which there was the second salt layer, 9 centimeters thick, below which there was a

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layer of viscous silt. As per previous data of the Mining Laboratory (1951 - 1952), the lake was qualified as bitter (from 21.63 to 40.36 percent of Na_2SO_4). Then analyses by Fedchenko (1970) showed, that the zone near the shore contained Glauber salt (sodium sulfate deanhydrate) up to 13 percent, while the mid-lake salt contained over 89 percent of NaCl, which is ready for use. At this time there are no operations proceeding.

Lake Seydin (or Sida), known as a lake containing large deposits of magnesium chloride, lies at 47 degrees, 15 minutes north latitude, and 46 degrees, 42 minutes east longitude, 52 kilometers to the west of Yeno-tayevsk. The lake is almost circular, 300 meters long, and 200 meters wide. The shores are steep (6-8 meters high), depth does not exceed 1 meter. The bottom is silty. The brine is thick, and of a brownish color. There is no fresh water near the lake, and its shores are uninhabited. The chemical composition of the brine is as follows: 1.680 percent of NaCl, 0.640 percent of KCl, 1.082 percent of $CaCl_2$, 0.080 percent of $CaSO_4$, traces of $CaCO_3$, 26.61 percent of $MgCl_2$, 0.253 percent of organic compounds.

In conclusion, it may be stated, that there is some data available pertaining to the microbiology of lake Tinaki.

The brine is a dense rose-colored liquid, retaining its color until August, then paling (Linevich, 944), and again assuming a rose coloration in May. Due to the surf, a thick rose-yellow-brown film is formed at the shores. Linevich published in 1929 a thesis pertaining to the nature of the brine coloring in the Tinaki mud lake. In this thesis, the author supplies some microbiological data relating to the composition of the brine. He segregated, in a conventional medium, five types of rod-shaped Aerobes, and one type of coccus, resembling staphylococcus. Two of the varieties gave colored cultures, the others were colorless. In 1929,

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Radishchev obtained a brine sample from Lake Tinaki. He noted its external similarity with the brine from Lake Il'tonskoye, except for its more intensive coloring. He diluted the brine with distilled water, and kept the liquid at rest for a month and a half, which resulted in a beautiful raspberry-colored precipitation. This precipitation consisted of continuous cultures of diplococci with rare small seaweed and their cellular particles.

7. ALLUVIAL RIVER DELTA

GENERAL DATA

The alluvial river delta [designated by the Russian word "lyman," which will be used throughout the chapter] in the Trans-Volga area (in the Kalmyk Steppe it is called "il'man'"), are terrestrial depressions, which are flooded in the spring by waters from the melting snows. They are of varied areas, from several square meters to several square kilometers. Most of the lymans are located in former Stalingradskaya and former Samarskaya gubernlyas. Small lymans, frequently ramified, in the Novouzensk rayon are called dips. The lymans usually lie in diluvial, silty, dark soils. The large lymans usually occupy considerably depressed areas sloping in a shallow manner towards the steppe watersheds. The most depressed areas are flooded, without running dry during the summer, and the surrounding slopes, due to abundant natural irrigation in the spring, become excellent hay harvesting parcels. The hollows are usually small, having an area from several square meters to one half of a hectare. The origin of the hollows, (according to Shumakov, 1486) is tied in with the leaching processes taking place in the soils under the effect of rain and spring waters. The saliniferous lymans (in most cases) have waterproof subsoil, rich in easily

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soluble salts. Very frequently, the saliniferous lymans are tied in with areas of considerable saline characteristics, these areas being known as saliniferous muds ("khaks" and "takyrs"). They occupy the areas of maximum depression, and are transitional to salt and bitter-salt lakes. The saliniferous muds have cumulative waters in their deepest parts, and along the edges a white incrustation of salts, under which there is dark strongly alkaline soil. The mud banks are covered with vegetation, all varieties of which are characteristically adapted to the chemical composition of the salts present in the soil. The hollows occupied by the saliniferous muds have sloping banks with steep terrace-like formations, from the foot of which there are shallow slopes to the salt beds.

In connection with the continuous excessive humidification, the lymans have a water cycle that is different from the one of the surrounding steppe. This is reflected in the structure of the lyman soils and their water-bearing characteristics, as well as in the characteristics of the vegetation, which, in its mass and variety is richer than the vegetation of the surrounding steppe. Precipitation, particularly in the form of spring melting of the snow, is of great importance to the water cycle of the lymans. By the virtue of this, the soil processes in the lymans have various annual directions. In years of abundant water supply, the currents bring to the lymans large quantities of water, containing salts in solution and silt particles. During the summer, the water in the lymans is partly evaporated, partly percolated deep into the soil, and carrying with it the salts in solution. The percolating, depending on the topography of the lymans, takes place with various intensities. Thus elevated places dry out more rapidly, while in hollows, the percolating and the washing-out processes are of greater intensity. The following regularities are observed in the distribution of

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soil differentials, with relation to the topography of the lymans (Dobrolyubov, 815): all high places of the lymans and their slopes are occupied by brown soils, high-alkaline soils, and saliniferous soils; somewhat below that are the gray lymanic soils; the lowest places, usually the central parts of the lymans, are occupied by marshy soils.

In the arid Trans-Volga areas, the lymans constitute valuable agricultural (hay-harvesting) parcels. Some of them are sources of water supply and livestock watering, and in recent years particular attention was given to the problems of investigation and reclamation. The table following below contains numerical data for some of the largest lymans of the Trans-Volga area (See Table on page 365 of original).

Water-collecting areas and gradients were determined by the plane table data from the survey of 1924-1928, All-Union Geodetic Administration, scale 1:50,000, with levels established at intervals of 1.25 meters and 2.50 meters.

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Name of Lyman	Area of Lyman Parcel, in Hectares.	Mean Grass Area of Lyman in Hectares.	Lyman Water-collecting area in Hectares.	Number of water-collecting areas, per 1 Hectare: of Lyman Parcel	Number of water-collecting areas, per 1 Hectare: of Mean Grass Area	Area of Sandy Loam and Sandy Soils in percent of overall water-collecting area.	Note on vegetation and Marshiness
Khrenovatyy							Quack Grass and Miscellaneous
Nye-spi Lyman							Quack Grass, Sedge, and Reed
Priship-zherav-linskiy							Marsh (800 Hectares)
Trifolosov							Quack Grass Miscellaneous. Sedge.
Perekrestniy							Quack Grass and Miscellaneous.
Bol'shoy Lyman							Bitters, Quack Grass, Miscellaneous, Sedge
Bogatyrev							Sedge, Quack Grass
B. and M. Zelnyy							Quack Grass, Miscellaneous
Medvezhiy							Weeds, Miscellaneous, Sedge, Reed and Marsh (300 Hectares)
Kryuchkov							Quack Grass, Miscellaneous, Sedge, and Marsh (40 Hectares)
Durnoy							Quack Grass, Miscellaneous, Sedge

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The mean gradients of the water-collecting area of the above enumerated lymans, computed as the arithmetical mean from the gradients of 8 main directions (not incorporated in the table), fluctuate from 0.0003 to 0.0018. The mean gradient for all the lymans is 0.00095. The mean cultivated parcel per one hectare of water-collecting area is 18.2 hectares. The mean grass area of a lyman is 30.4 hectares.

THE LYMANS OF PRISHIB-MOGUTA

The above named lymans are located in the former Nikolayevsk county of Stalingradskaya guberniya, 35 kilometers to the southeast from Nikolayevsk Station on the Volga, and 32 kilometers from Kislovka Station (49 degrees, 40 minutes north latitude, and 45 degrees, 45 minutes east longitude). The terrestrial hollow, containing the net of Prishib-Moguta lymans, is a parallelogram extending 30 kilometers from northwest to southeast, and 24 kilometers from northeast to southwest. The net consists of 2 groups: (1) Prishib and Zhuravlinskiy, with an area of 2650 hectares, and (2) Moguta, Prishibok and Shoyka, with an area of 2550 hectares. In medium-water years the Prishib-Zhuravlinskiy lyman comprises a flooding area of 1,850 hectares, with a maximum depth of 0.5 meters, while the Prishib-Mogutinskiy lyman comprises a flooding area of 1,500 hectares, with a maximum depth of 1 meter. In abundant-water years, the flooding area and maximum depth are correspondingly increased, for the first group to 2,300 hectares, with a maximum depth of 0.60 meters, and for the second group to 2,400 hectares, with a maximum depth of 1.40 meters. The first group of lymans is separated from the second group by a channel 900 meters long and 60 meters wide. When the Prishib-Zhuravlinsky lyman is filled the water begins to flow, through the channel into the second group, which, incidentally, happens on rare occasions only. The water-collecting area

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of the Prishib-Zhuravlinskiy lyman comprises 45,350 hectares. The Prishib-Mogutinskiy water-collecting area comprises 28,350 hectares. The points of maximum distance, from which the spring waters flow into both groups, are 8-9 kilometers away, and the nearest water shed boundary is 4 kilometers away. The mean gradient of the terrain containing the entire water-collecting area of this group of lymans is 0.00095. The water-collecting area of the first group of lymans is the most dissected with ravines and rivulets. Ten ravines and rivulets from 16 to 22 meters wide, flow into the Prishib lyman. Two small ravines, 400 to 500 meters long, flow into the Prishibok lyman from the southeast. No ravines or rivulets flow into Zhuravlinskiy and Moguta lymans. The level of the sub-surface waters in the water-collecting area of the lymans has a definite lateral down-grade relative to the direction of flow. For example, at the lyman, the level of the sub-surface waters is at a depth of 3.0 meters from the surface. At a distance of one kilometer from Prishibok to S---na, it is at a depth of 6-7 meters from the surface. Further to the north, this depth of level from the surface is increased, and in approaching the watershed boundary, it is down to 14-16 meters. The accumulation of water reserves in the lymans is closely tied in with the intensity of the melting of the snow. In 1917, the period of snow melting was only 8 days, resulting daily in 14,600,000 cubic meters of water; in 1919, the period of snow melting was 11 days, resulting in only 5,000,000 cubic meters of water per day. The net of Prishib - Mogutinsk lymans is situated within the boundaries of a semi-desert area of inadequate humidification, as a result of which the vegetation of the surrounding steppe is xerophyte /drought-resisting/ in its nature. The overall background of the steppe is created by the gray wormwood formations, with the addition of sandy milkwort (Euphorbia Geranica), quack grass (Agrofyrum Repens), or black

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wormwood. In approaching the lymans, the lower third of the slopes is covered with pyrethrum grass formations growing in argillaceous soils. The steeper slopes are covered with sweet grass. In depressions, where there is some stagnant water in the spring, there is growth of gray wormwood. In direct proximity to the lymans, there is saltwort and small quantities of sedge grass. Where there is much stagnation of spring waters, or continuous stagnation, as during abundant-water years, reed formations (Phragmites Communis) and other non-floating vegetation are found on the bottom of the lake parts of the lymans.

In the area of the Mogutа-Prishib lymans, V. Solov'yev (1937) established the following diagram of soil types: (1) steppe-complex soils, (2) steppe-aronose, a variety of complex soils, (3) area near the lymans -- saline variety of complex soils, (4) lyman-upper ring -- lymanic -- saline soils, (5) lymans' lower ring -- peat-lymanic soils, (6) lake and semi-marshland soils. A similar classification of vegetative soil formations is present in other lyman networks of the Trans-Volga area. The distinctive features of individual lymans are in the fact that some are situated on flatbanks, some in depressions of various degrees; in some, aronose soils predominate, in some -- argillaceous soils. They are also distinct from one another by the duration of the flood stage.

To the south of the system Prishib-Mogutinsk, there are many small hollows, the so-called "dip saucers," with a diameter of 5-10 meters, and a depth of 0.5 to 0175 meters. These are a result of the settling of the soil taking place during the leaching process.

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THE ZENIN LYMAN

The Zenin lyman lies 30 kilometers to the southwest of Novouzensk. It has an elongated shape and consists of two depressions occupying an area of one and a half kilometers. Its depth, with relation to the surrounding steppe, is about 3.0 meters. The steppe has a brown soil and rare vegetation, consisting of bushes of black wormwood, Artemisia fauciflora, Pyrethrum Achilleifolium, and other semi-desert vegetation. The bottom of the lyman is covered with a continuous layer of quack grass. F. P. Savarenskiy (410) cites the data obtained by exploration drilling conducted for the purpose of soil analysis and for the determination of the water-bearing characteristics of the underlying strata.

The volume of subterranean waters in the lyman increases with depth, the water becoming saline at the depth of over 20 meters.

Data on the variation of the saline composition of the water, as dependent on the depth of the soil strata, indicate a sharp increase in the mineralization of the deep subsoil waters in the lyman area. This characteristic is of great interest, since it confirms the theory of the saliniferous origin of the Lower Volga lakes, as tied in with the salt deposits of the deep subsoil strata.

THE LIPIN LYMAN

The Lipin Lyman, having an area of 5 square kilometers, lies 20 kilometers to the southeast of Aleksandrov-gay Station. The lyman consists of a series of inter-communicating depressions in the surrounding steppe. The lowest points of the depressions (the depth of the lyman) are 0.7-0.8 meters below the surface of the surrounding steppe. Vegetation and soil conditions are identical with those of the Zenin lyman. Mineralogical analysis of the soil waters, within the boundaries of the lyman, as well

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as nearby, established the distribution (in milligrams per liter) of fresh and high-mineral content waters, as per following table. The distilling effect of the lyman waters upon the subsoil water, and the degree to which the lyman waters penetrate in depth, is thereby indicated.

Depth of water-bearing strata	Bore holes in the Steppe near the lyman	Bore holes in lyman proper		
		2	3	4
I. Upper strata				
II. Strata 8-15 meters deep.				
III. Strata 17-25 meters deep.				
IV. Strata 27-30 meters deep.				

C. MARSHLANDS

THE DEGREE OF SWAMPINESS ALONG THE LOWER VOLGA AND THE MAIN MARSHLAND GROUPS

The dominating geographical factors determining the degree of swampiness, the distribution of marshlands, and the prevalence of this or the other type of marshland, within a certain area, are the climate and the orography of the area. The greater part of the Lower Volga area, with the exception of its northern and northwestern part, is in the arid zone. This climatic feature precludes the conventional /mode/ of evolution of swamps, and only orographical characteristics, such as topographical configurations, geological features, and soil characteristics, create the conditions for the formation of individual swamps, as dissemination in the surrounding steppe.

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With relation to topographical configuration, the area may be divided into two parts: (1) the higher-elevation part, comprising the narrow strip of the right bank of the Volga (up to Stalingrad), and the northeastern part of the area, and (2) the lower strip of the left bank of the Volga, and the southern part of the area. It should be noted, that even in the higher-elevation part of the area, the locality is rarely mountainous, but is rather a dissected mass of flat eminences, forming the flat watershed spaces between rivers. These topographical eminences, in the northeastern part of the area, are covered either with pine forests, a combination of pine and oak, or a continuous oak forest. The rivers flowing through here have wide valleys, which are frequently swampy and covered with willow and alderwood. The low-lying part of the area, merging into the Aralo-Caspian lowland, is, at the Kamyah-Samarsk lakes and at the Large Uzen' spillways, from 2.5 to 5 meters below the level of the Baltic Sea, and is predominantly a bare, waterless, and saline steppe.

The same sharp diversity, tied in with the water cycle in these parts, can be observed in the distribution of soils. While on the right bank of the Volga and in the northeastern part of the area black earth soils prevail, the soils in the other half of the area are chestnut and light-brown dry steppe soils, sandy loam, arenose soils and sands, with considerable amounts of saline soil mixed in.

The concentration of the marshlands in the north and the northeast of the area is tied in with the above described conditions. There are no typical swamps to the south of the line Saratov-Buzuluk (on the Samara River). However, the available data is not complete. There are a series of formations, which, although not typical, may still be considered, to some extent, as marshland, to the south of the above line.

In order to compute the marshland area along the Lower Volga, 62

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basic river basins were segregated. Swamps were registered only in 24 basins, the area of which, according to a map drawn to a scale of 1:420,000, was computed to be 12,302,000 hectares, or about 31 percent of the entire area in question. The remaining area (38 river basins), where no swamps are registered, comprises 27,562,000 hectares, or 69 percent of the whole. The total area of marshlands is only 9184 hectares. The mean percent of swampiness for the entire area is 0.02 /percent/, which points to the fact, that marshland is not a characteristical element in the geography of the Lower Volga. The mean percent of swampiness for the part of the area (24 river basins), where the marshlands were registered, is 0.07 percent, not important enough even for this part.

The largest concentrations of marshland are in the basins of the following rivers: Usa -- 12 swamps (area 1495 hectares), Syzran' -- 37 swamps (area 720 hectares), Large Cheremshan -- 12 swamps (area 1257 hectares), Little Cheremshan -- 12 swamps (area 1294 hectares), Karmala -- 2 swamps (area 609 hectares), and in the bottomland of the Volga -- 12 swamps (area 961 hectares). A total of 87 swamps, with a total area of 6,426 hectares.

Thus, 62 percent of the total number of swamps, and 70 percent of the total area of marshland are concentrated within the above enumerated river basins. As to the percent of swampiness in individual river basins (with relation to the total marshland area), the figures are different. A maximum degree of swampiness occurs in the following river basins: Karmala -- 1.26 percent, Usa -- 0.78 percent, Timerka -- 0.78 percent, Tiya -- 0.61 percent, Utka -- 0.54 percent, Uren' -- 0.49 percent, Little Cheremshan -- 0.41 percent, Syzran -- 0.36 percent, Mayna -- 0.26 percent, Kamayur -- 0.24 percent, Large Cheremshan -- 0.23 percent, and Bezdra -- 0.23 percent.

Finally, by areas, the individual swamps are distributed in accor-

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dance with data presented in a table on page 307 of the original.

Sequence Numbers on Map	Name of River basins	Total Number of Swamps	Number of Swamps with an area: up to 100 Hectares	from 100 to 500 Hectares	over 500 Hectares
	Volga				
	Bezdna				
	Utka				
	Mayna				
	Uron'				
	Kamayur				
	Large Cherzmshan				
	Large Sul'cha				
	Chemerlik				
	Little Cherzmshan				
	Tiya				
	Karmala				
	Tashoka				
	Kondurcha				
	Borovka				
	Kinel'				
	Mochegan				
	Usa				
	Timerka				
	Tukshum				
	Syzran				
	Bekshanka				
	Tomashorka				
	Kurlyum				

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Swamps with an area of 100 hectares are predominant, then follows the group of swamps with individual areas up to 500 hectares, of which number only a few exceed 100 hectares in area, and only one swamp (Rep'yevskoye) has an area of 511 hectares. Thus this data additionally confirms the fact that marshland is not a typical feature of the Lower Volga landscape.

Finally, it is necessary to take note of formations, which cannot be considered as swamps in the accepted sense of the word, yet, by some characteristics, may be judged to be formations of the latter type. These are the so-called meadow swamps lying in the spillway bottom lands of the rivers, which are particularly extensive in the bottom land of the Volga, downstream, between the Volga and the Akhtuba, and also in the vast delta of the Volga; also the saline lymanic marshes; and, finally, the spillways of the Large Uzen' River. The areas of these formations were not definitely established. They are, however, roughly marked out on the attached map of the marshlands.

TYPES OF SWAMPS AND THEIR DISSEMINATION

All the investigated swamps in the area belong to the following basic types: (1) upper [upstream?] (mossy), (2) transitional, (3) lowland (grassy, meadow type), (4) lymanic-saline, and (5) miscellaneous. The distribution by types is shown on the attached map, and for the first 3 types, in table on page 374 of the original. It should be noted that miscellaneous swamps occupy 15.1 percent of the total area of the swamps investigated, while the areas of the lymanic swamp formations were not computed with precision, and are, therefore, not included in the table.

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The tabulated data establishes the predominance in the area of the lowland type swamp, to the extent of 89.1 percent of the total marshland area. The transitional type of swamp is next, occupying 10.3 percent of the total marshland area. The upstream type of swamp occupies only 0.6 percent of the total marshland area. Distribution of swamps by types within the individual river basins shows considerable fluctuation. Swamps of the transitional type predominate only in the basins of the Ures' (94.1 percent); the Tiya (69.3 percent). They are rather considerable in the basin of the Bezdna (43.9 percent) and less so along the Volga (21.1 percent).

Upstream swamps, completely non-typical for the area, predominate only in the basin of the Bekshanka, a tributary in the upstream of the river Syzran, to the extent of 78 percent. This falls in naturally with the topography of this location, which is an elevated watershed, between the rivers Barysh and Sviyaga. In addition, the upstream swamps are encountered in two other basins, that of the Syzran itself (3 percent) and of the Tomyshevka (3.5 percent), being, however, subordinate there to other types (lowland swamps). In all other river basins, lowland swamps predominate.

The lowland marshes of the area have a flat surface, a shallow slope (0.002 to 0.0002), and are frequently covered with wooded and undergrowth vegetation, such as willow, alder, linden, birch, and buckthorn.

The following sub-types can be segregated out of the basic lowland type-swamp:

(a) Green-moss Hypnoid Swamps, with the following typical vegetation : hypnoid mosses, horsetail (Equisetum liposum), cinquefoil (Comarum palustre), marsh trefoil (Menyanthes trifoliata), valerian (Valeriana officinalis), orchis, willow (solix), rarely, birch up to 15

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years. Marshes of this type predominate in the basins of the large and Little Cheremshan rivers.

(5) Lowland sedge-reed Peat bogs, with the following typical vegetation : varieties of sedge, beach grass, reed (Phragmites communis), large crowfoot, cinquefoil, bedstraw, loosestrife, lythracea, willow; in hollows and on swampy and silty banks arrow rush, reed mace, water plantain, arrowhead (Sagittaria sagittifolia), flowering rush (Butomus umbellatus), frog-bit, duckweed, cat reed, bladderwort, buttercup; in higher spots, pyrola, nettle, spiraea, and birch.

Meadow Marshes (mineralized swampy meadows in the bottomland of rivers). This type of swamp is encountered mostly in the spillway area of the Volga. The meadow-swamp vegetation becomes considerable between the Volga and the Akhtuba, particularly, downstream, in the vast delta of the Volga. This lowland plain with its vast network of branches, channels, ravines, il'men's, and lymans is flooded with swollen spring waters for a period of from 1 to 2 months. The receding waters leave moisture-saturated meadows covered by abundant grassy vegetation, and, in the depressions, particularly, around the il'men's, baylets, and river reaches -- swamp vegetation (Callitrichaceae). The meadow marshes usually abound in willow undergrowth (Salix cinerea, Salix acutifolia, Salix amygdalina), and black poplar. In the grassy row predominate: flowering rush, water plantain, arrowhead, and sedges (Carex riparia, Carex paludosa, Carex vulgaris).

Sedge grasses constitute the basic background of meadow marshes. Their rootstocks frequently form hillocks, covered with sedge grasses, filled with stagnant water. Here grows buttercup (Caltha palustris) and a grass known as Pedicularis palustris.

Typical for these marshes is water arum (Calla palustris), at times

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there is black currant (Ribes nigrum), or a grass known as Rubus caesius, swamp rush grass (Scirpus palustris) and cotton grass (Eriophorum vaginatum, Eriophorum gracile). On the hillocks there is forget-me-not (Myosotis palustris), fetid horo-hound (Lycopus europaeus), water hemlock (Cicuta virosa), horsebane (Oenanthe phellandrium), swamp fern (polystichum thelypteris). In the delta of the Volga there is considerable growth of willows and reeds. The reeds (Phragmites communis) and reed mace (Typha latifolia, Typha angustifolia) predominate in the lowlands near the seacoast, where they stretch in a belt several kilometers wide. The banks of all the slow-flowing rivers are covered with reeds, which, together with reed mace, encircle all the il'men's, bayleks, and river reaches, covered with swamp vegetation. Of frequent occurrence are dead-end il'men's, encircled by a wide belt of reed and reed mace, the latter forming the outer ring, within which there is a belt of yellow water lily (Nuphar luteum and Nymphaea alba). Also here, are the "devil's nuts" (Trapa natans), and , at times, bladderwort (Utricularia vulgaris). The inner ring is formed by growths of reed. Of rarer occurrence, are small il'men's with soft argillaceous soil. Reed and reed mace does not completely encircle these il'men's,yet there is ample growth of it. Around the il'men's of this type, there is a particular diversity of vegetation, such as: naiads (Najas maior, Caulinia fragilis), pond weeds (Potamogeton perfoliatus, P. lucens, P. natans), frog-bit, featherleaf (Myriophyllum spicatum). The bottom of the il'men' is covered with aquatic plants (Ceratophyllum demersum) and characeae, while duckweed (Lemna minor) is floating on the surface. In spots, there is eel grass (Vallisneria spiralis), and, in rare spots, Indian lotus, or water rose (Nelubium speciosum).

Turning now to the saline marshes of the lymans, it may be noted that the part of the Volga left bank, which is a low-lying plain, has no

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active river net-work, but is criss-crossed by many flat-bottom depressions of various size and form, and lakes in various stages of salinification. Depressions, occupied by the lymans, frequently have an area of several thousand hectares. They are filled by spring floodwaters, which are frequently sustained through the summer by subsoil moistening. When the moistening, due to the proximity of subsoil waters, is continuous, the lymans form meadow swamps, with all the turf and meadow vegetation that goes with it. Then there are lymans with only temporary surplus waters, or with subsoil moistening only. In the later case, either along the entire thickness, or in the deeper soil strata, there is an accumulation of easily soluble mineral salts, which creates in some spots, a depth extension of swampiness (Rushinskiy, 024). In this case, there is the formation of a special type of lyman -- a saline marsh with corresponding vegetation, such as reeds, sedges and others. Thus, the saline marsh soils develop in areas of excessive moistening, with the support of subsoil waters. Observations established the fact, that a lyman, left to itself, will begin to grow over with vegetation, i.e. marshy vegetation, in a non-reversing manner, displaces useful vegetation.

An annular zonality is apparent in the distribution of lymanic vegetation. In depressions, where spring waters are stagnant for a time, there is gray wormwood. In the immediate proximity of the lyman, on the dark and strongly alkaline soil, there is an agglomeration of saltwort, lying in a ring around the edge of the lyman. The upper ring of the lyman proper is occupied by the strongly alkaline lymanic soils (soils in the process of drying out), which are covered with herbaceous vegetation, changing from sweet to sour, with an admixture of sedge, as it descends deeper into the lyman. Below is the largest (in area) ring of several varieties of

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sedges. Further down, there is surface gornel and even peat, as a result of which the lower ring of the lyman comprises peat soils, with sedge, lytraceae, and plantain growths. At the bottom of the lyman, and in its lake part, the above become semi-marsh soils, with the initial formations exposed. In places of protracted, or continuous water stagnation, the bottom of the lake part is overgrown with reeds (Frapmites communis), or various non-floating water vegetation.

On the map depicting the swamps of the area, only the largest (Prishib-Mogutinskiy) lyman, located on the Volga, 37 kilometers to the southeast of Nikolayevka, and 34 kilometers to the east of Kinlovo station, is shown. The lymans occupy the lowest part of the Prishib-Mogutinsk hollow. There are two groups: the Prishib Zhurovlinskiy group, with an area of 2950 hectares, and the Mogut-Prishibok-Shoyka group, with an area of 2797 hectares. 218 hectares of the first group and 655 hectares of the second group, a total of 873 hectares, become stagnant during medium-water years. During abundant-water years, 437 hectares out of the first group and 874 hectares of the second group (a total of 1,311 hectares), become stagnant. (Chertonsov, 534). The above described annular zonality of soil and vegetation formations was discovered in this lyman.

Finally, some individual marsh formations, so-called diffusions, have been segregated. They occupy large areas, mainly, between the rivers Bol'shoy and Malyy Uzon' and the river Kushum. Since these areas were not accurately computed, they were not included in the table. The Chizhinsk and Dyurinsk diffusions are the most important ones.

According to data collected by I. V. Larin (056), the area of the Chizhinsk diffusions contains two basic elements of topography, such as the dry steppe and meadows, with the meadows occupying the lower terrain. The meadows, called lymans, are not homogeneous: in most cases, three micro-relief terraces are segregated, with the third, or lower, terrace

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having the characteristics of a water bank, or even a swamp. Spring waters flood the surface to a depth of from 10 to 30 centimeters, and only in the narrowest spots to a 1 - 2 meter depth. During the summer (July), water remains in the lowest parts only, the so-called clusters, which are occupied by water bank vegetation, such as reeds, rushes, and reed mace. The vegetation rotation, as from the soils of the upper places to the water clusters below, shows an annular zonality.

In the changes of the soil downward into the depth of the water cluster, there is the following sequence: (1) dark alkaline soild, (2) light sulfo-chloride salt bottoms /sulfate and chloride compounds/, (3) salt mash, (4) dark salt bottoms, (5) various salt bottoms and saliniferous soils, (6) a variety of dark alkaline soil, and (7) stagnation soils with Phagmites [illegible] Scripus.

The centers of the water clusters, the so-called saucers, are of two types: with leached out soils under fresh (or slightly saline waters, and with saline soils. As a rule, the water cluster is separated from the middle meadows by a raised surf slope covered by heterogeneous vegetation. The upper part of the slope is covered by meadow vegetation, joined by: reed (phragmites communis), Alisma Plantago, Agrostis alba, Bechania crucaeformis, and others. The bottom of the slope, near the water, is overgrown with typical water-bank vegetation, such as : flowering rush (Butoms umbellatus), water plantain (Alisma Plantago), sedge (carex nutans), and others. In the water appear growths of reeds and rushes (Scripus lacuster), reed mace (Typha latifolia). In fresh water, between the above, there are spots and circles of sedge (Carex gracilis, Carex vesicaria), Scholochloa festucacea, and Nasturtium amphibium. In more saline water, these are absent, their place being taken by "nyun'ka" (Scripus maritimus). The most important vegetation in the water clusters are reeds, rushes, and

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"nyun'ka" (Scirpus maritimus). When the water clusters are of considerable depth, and the water is there to the end of summer, typical water vegetation develops, with pond weed (Potamogeton Lucens, P. perfoliatus, P. obtusifolius, P. natans), nuckweed (Lemna minor, Lemna trisulca), bladderwort (Utricularia minor), and crowfoot (Ranunculus circinatus). Water vegetation of deeper zones, such as water lily (Nimphaea alba, Nuphar luteum), Polygonum amphibium, is encountered rarely.

LOCATION OF MARSHES WITH RELATION TO RIVER SYSTEMS, LAKES, AND WATERSHEDS

When the map of the marshlands in the area is compared with the topographic map of the area, it can be seen, that the greater number of marshes is located in the river valleys. This is perfectly natural, since most of the marshes, as was established in the preceding text, belong to the type of lowland marshes, usually tied in, to some degree, with the activities of rivers, or with the topographic depressions. As is known, the water divide marshes are usually of the upland type. This was already noted with relation to the upland marshes of the area, concentrated in the basin of the river Syzran and its tributaries, since in that part of the area, the terrain is higher. In addition, many marshes of the northern half of the area are located near the rivers proper, frequently in their bottomland spillways and near the terraced parts. However, the most typical in this respect are the meadow marshes, which are located in the bottomland spillway terrace of the Volga and in its delta, and are closely tied in with the water volume turnover of the river itself.

All the other marshes in the southern part of the area, such as the lymanic and diffusion marshes, are tied in directly with the blind flat-bottom depressions, which are flooded by the spring waters, and are, usually,

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non-draining cisterns, or depressions in the terrain. Thy lymanic marshes are usually disposed around lakes, the waters of which fill up the lowest parts of the lymanic hollows. The same is observed in the bottomland parts of the Volga, where, as was already mentioned before, swamp vegetation abides predominantly around the lakelets, channels and il'men's, which criss-cross the bottomland of the Volga, and, particularly, its delta.

THE ORIGIN OF SWAMPS

The swamps of the Lower Volga area, with relation to their origin, are tied in with the topographical, hydrographical, and soil conditions, which caused a retraded moisture turnover and excessive moistening in some parts of the area. Less frequent are some artificial causes, such as the foundations of the mill dams in the rivers Bol'shoy and Malyy Cheremshan, and others. In the majority of cases, these basic causes are tied in directly with the [dynamic] cycle of the river net, such as, for example, the absence of a pronounced longitudinal and transverse slopes in the bottomland, the development of a shore embankment, the prolonged flooding of the valleys by spring waters, the presence of hillocks and under-growth-ligneous vegetation. Many swamps in the basins of the rivers Mally Cheremshan and Bezdna are narrow stretches along a river, or lake, which indicates their origin as tied in with the initial evolution of the stream beds. A contributing factor is the presence in the area of argillaceous water-impervious sub-soils. All the above factors causing the detention of the surface and subsoil run-off in the bottomlands of the rivers, are the basic reasons of swamp formation, particularly, in the northern part of the area.

The origin of the swamps in the southern part of the area is due, mainly, to the filling of topographic depressions by spring waters, periodic flooding of these depressions by the sustaining of the excessive

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moistening by the supporting sub-soil waters (in the lymans).

The main source of the feedwaters for the marshes of the northern and the northeastern part of the Lower Volga area, are the spilling over of the rivers and the run-off from the water-collecting area, but very rarely the sub-soil waters. The part played by atmospheric precipitation is not too significant, since the amount involved is small. With relation to the swamps in the southern part of the area, tied in with the bottomland of the Volga, the main factor is the spilling over of the river, with the water remaining over the bottomland for a period of 1 - 2 months.

The lymans usually have large water-collecting areas, filling up with the spring waters and retaining them for the entire summer, at times even through autumn. The shallower depressions run dry after the snow is gone, and, during the summer, become completely parched. The moistening effect of the sub-soil waters plays an essential part in the water cycle of the lymans, with saline marshes evolving, specifically, in locations with abounding sub-soil waters.

DESCRIPTION OF THE MAIN MARSHES

The marshes studied for the purposes of this Manual, comprise 59.9 percent of the total marshland area, and 30 out of the total number of marshes. The best known, are the marshes in the basins of the rivers Bezdna, Uren', Bol'shaya Sul'cha, Karmala, Kurdyum, followed by Bol'shoy and Malyy Cheremshan, Bekshanka, and partly the Volga and the Utka. The swamps in the basins of the rivers Usa and Syzran are among the least studied ones. The swamps occurring in the south of the area, were not adequately investigated, and, therefore, not included in the tables that follow the text. Thus, the number of marshes, cited in the tables, is

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obviously below the actual number in existence, and the actual degree, to which the marshes were investigated, is probably below the one cited in the Manual.

From the more or less complete descriptions, two, referring to the marshes of the northern half of the area, were chosen, but even these are not fully adequate. Therefore, it is relevant to cite some general data pertaining to the marshes of the Lower Volga area.

The peat of the lowland marshes is predominantly of the sedge, sedge-ligneous and hypnoid type, frequently with admixtures of reed. The degree of decomposition is usually medium. In some cases, there are mineral particles and calcium carbonate (in the basins of the rivers Reazna and Malyy Cheremshan), and, at times, Marl (in the Endov swamp).

The mean depth of the peat deposit for the entire area, as computed from the data on all the marshes studied, is 1.4 meters. By individual river basins, the mean depth of the peat deposit is as follows: Karmala - 2.63 meters, Volga - 1.67 meters, Usa - 1.56 meters, Timerka - 1.65 meters, Bol'shoy Cheremshan - 1.68 meters, Tukshum - 3.33 meters, Syzran - 1.53 meters. The maximum depth of a peat deposit, 3.6 meters, occurs in the Klin swamp, located in the former Syzranskiy okrug [district].

In view of the low quality of the deposits, their exploitation for industrial purposes is not developed. They are mostly utilized by the populace for pasturing and hay-making purposes. Regarding some swamp vegetation in the bottomland of the Volga, there is data on the utilization of swamp rushes for roof tops and for the brick kiln installations in the southern part of the area.

The Vyazovskoe swamp. The swamp is located in the Vyazovskiy Rayon, near the village of Vyazovka, 35 kilometers to the northwest of Saratov, 20 - 25 kilometers to the northwest of Kurlyum Station on the R - Ural

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railroad, 0.5 kilometers from the village of Myzino-Lapshinovka, and is within the exploitation area of Kokhoz Utkinskiy.

The swamp is of the lowland type, on the right bank bottomland of the river Staritsa. Adjoining the swamp, are high and dry mounds. The total area of the swamp 154 hectares, out of which 70.83 hectares represent the industrial /peat/ deposit, and 67.33 hectares -- the mounds and ditches.

The surface of the swamp is elevated at the center, sloping down toward the river. There are small hillocks in spots. Vegetation is of the undergrowth-ligneous type, such as: alder (diameter 3 - 6 centimeters, height 3 - 5 meters), willow (diameter 2 centimeters, height 2 meters). The grass covering consists of sedges, reeds, ferns, hops, nettle, and other meadow grasses.

The mean depth of the peat deposit is 1.44 meters, its maximum depth is 1.74 meters. Mean peat body thickness is 0.15 meters. Raw peat reserves amount to 1,100000 cubic meters. The peat is of the sedge, ligneous variety and of medium decomposition stage. Ash content in the presence of 30 percent moisture, is 20.6 percent; its heating capacity is 2233 small calories. Stumpiness is insignificant. The subsoil of the swamp is grayish clay.

The feedwater sources are as follows: atmospheric precipitation, spring waters running off from the mounds, and a series of small springs located within the swamp. This swamp underwent preliminary draining. A system of ditches, connecting into a main ditch, flowing into the river Staritsa, the main water intake of the system, completely insures circulation. In addition to the main ditch, there is a brook flowing into the river. The slopes of the ditches and the brook are considerable. The swamp is comparatively passable. It is partly utilized for truck gardening. It was investigated in detail by Krayzu in 1931.

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The Mokroye /wet/ Swamp. The swamp is located in the Kolyshleysk Rayon of the Nazvanovskiy Rural Soviet of the Nove-Volzhskiy Kray, between the villages of Nazvanovskaya and Sushchevskaya, at a distance of 2.6 kilometers from the rayon administrative center, which is also the Kolyshley Station of the Ryazan'-Ural railroad.

The surface of the swamp is even, with a rise of 0.4 meters to the northeast. Its slope to the southeast, towards the river Kolyshley, is 0.001. The lowest point mark /Otmetka/ of the swamp bottom is 0.00 meters; the mark of the waterline at the bank of the river Kolyshley is 5.02 meters. Thus, the swamp can easily be drained.

The swamp is of the lowland type, covered with small hillocks, attaining a height of 0.4 meters in the northeastern part. Among the grasses narrow-leaf sedge is predominant; the ligneous vegetation consists of undergrowth, white willows and alder, attaining a height of 2 - 3 meters.

The mean depth of the peat deposit is 1.38 meters, the thickness of the peat body is 0.20 meters, raw peat reserves amount to 376,350 cubic meters. The peat is of the sedge type, low-grade, yet can be utilized as fuel. Its color is dark-brown and chestnut. The degree of decomposition is from 55 to 75 percent. Ash content, in the presence of 30 percent moisture is 23.9 percent. There is much mineral matter. Stumpiness is absent. Heating capacity, in the presence of 30 percent moisture is 1756 small calories.

The swamp is fed mainly by atmospheric precipitation. The vegetation cover, undergrowth, and hillocks reduce the rate of the surface run-off. The main water intake, the river Kolyshley, flows at a distance of 300 meters from the swamp. A partial draining was accomplished, but the molding machine method of mining peat requires an additional drainage net. The swamp is partially passable. It was investigated in 1927, and at

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present is not being exploited.

All the above data indicates that marshes are only slightly developed and are non-typical for the area of the Lower Volga. However, considering the fuel deficiency, particularly, in the southern part of the area, the exploitation [peat mining] of some of the swamps becomes economical. It is obvious, that such swamps will attain their maximum evolution in the northern and northwestern part of the area, where, in their characteristics, they approximate the marshlands of the Middle Volga. As to the marshland areas of arid southern parts of the area, they can be utilized as fodder reserves, of which there is here a notable deficiency. Particularly useful, as such, are the meadow marshes and diffusions of the Volga bottomland.

Hydrologically, the marshes of the Lower Volga area are of no considerable interest.

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THE SWAMPS OF THE LOWER VOLGA WITH RELATION TO THE DEGREE THEY WERE INVESTIGATED (Page 373)

Numbers of River basins on map	Name of Basin	Total Number of Swamps	Total Area in Hectares	Number of Swamps Investigated	Area of Swamps Investigated	Percent of Swamps Investigated in Relation to Total Number of Swamps	
						By Number	By Area
1	Volga						
2	Bezdna						
3	Utka						
4	Mayna						
5	Uren'						
6	Kamayur						
7	B. Cheremshan						
8	B. Sul'cha						
9	Chemerlik						
10	M. Cheremshan						
11	Tiya						
13	Karmala						
15	Tasholka						
19	Kondurcha						
27	Borovka						
28	Kinel'						
30	Mochegay						
49	Usa						
50	Timerka						
51	Tukshum						
52	Syzran						
53	Bekshanka						
55	Tomyshevka						
59	Kurdyum						
	Total.....						

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Ground Waters of Hard Fundamental Strata

The water-bearing layers of the hard strata, coming out to the surface within the boundaries of the Nizhneye Povol'zhe, until the Jurassic period inclusively, form a top sub-surface water layer (verkhovodka) only partially in those places where these layers are not bedded deeply under the diurnal (dnevnaya) surface and are not covered over by layers of more recent strata, i.e., in the regions of supply for these layers. As for the water content of the Permian and anthracite strata, in the regions of supply they usually are waterless to a considerable depth, without any surface water-bearing layers. This is explained, evidently, by the strongly fissured nature of the limestone, included in the strata, which make up the indicated systems, and also by the presence of cavernous appearances in places where the limestone comes out onto the diurnal (dnevnaya) surface. The above-mentioned conditions make it possible for the water to penetrate quickly to the deep strata.

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The Aral-Caspian Lowland

The region having artesian waters originating in Caspian deposits is that part which extends from Yergeni to the east past the boundaries of the Lower Volga and in the south from the latitude of Novouzensk to the Caspian Sea. Together with the Caspian deposits there are a number of artesian levels of which little study has been made.

The most interesting information about the artesian waters of the Caspian deposits has been obtained from the Sayalinskiy borehole. This borehole passed through four layers of artesian waters, of which the first three gave water with great pressure. Information about the depth of the occurrence of each water layer, its established level and calculations of the pressure are shown below:

Name of Water Layer	Depth at Which Water Appeared	Established Level	Pressure
First layer	25.56 meters	8.50 meters	17.06 meters
Second layer	42.90 meters	4.25 meters	38.65 meters
Third layer	120.35 meters	1.00 meters	119.35 meters

All three water layers are related to the Caspian sands. A large discharge was observed only in the first bed. In the second water layer the level fell sharply after one hour's pumping. The same occurred in the third layer. The quality of the water was very bad.

The boreholes, frequently very deep, along the Astrakhan line of the Ryazan'-Ural'sk Railway show that from Kaystaskaya Station to Seroglazov Station there is no fresh water in the deep water layers except for Pallasovka, Shungaya, Baskunchak, and Bogdo. The artesian borehole at Shungaya Station gives off water from the second water-carrying stratum, occurring at a depth of 36 to 60 meters. The borehole is 65,200 meters deep and its lower part is tamped because it penetrated into the third water-bearing layer with salt water. Four artesian boreholes, which take

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water out of the second water-bearing layer 26 to 52 meters deep, have been constructed for the water supply of the East Baskunchak Station. At the same time in the second borehole the normal water level is twenty-three meters, in the third twenty-five meters. Analyses which have been conducted (see chart) show that the composition of the water for the second water-bearing layer is of good quality, and some cases is softer than the water of the Volga.

The artesian borehole for the water supply of Bogdo Station has been drilled down to the second waterbearing layer occurring at a depth of thirty to fifty meters. The borehole has abundant water. The quality, however, is worse than that of Eastern Baskunchak Station (see chart). Other boreholes which have been bored north of Shungay Station, at Sary-Kain Station, to a depth of 80 and 115 meters, at Shanybek Station to a depth of 120 meters and at Karpatskaya Station to a depth of 121 and 122 meters have been investigated, but gave unsatisfactory results. In this way it was shown that in the area investigated good artesian water may be obtained in the region from East Baskunchak Station in the north to Shungay Station, from the second water-bearing layer located at an average depth of 40 to 50 meters. At East Baskunchak Station this water bearing layer thins out, for here the strata of the Jurassic period appears in the form of islands, surrounded by Aral-Caspian deposits. Farther south than East Baskunchak Station there again appears an extremely abundant water-bearing layer with satisfactory water, but it contains more salt than that in the area from East Baskunchak Station to Shungay Station. North of Shungay Station, satisfactory water having pressure has not been detected though boring has proceeded to a depth of 120 meters. Drillings at Chapchachi Station to a depth of 85 meters and at Seroglazov Station to a depth of 72 meters have detected only salt waters. In this way, in the area around Akhtuba, Akhtuba River with its tributaries and lakes serves as almost the sole source of fresh water. It is evident that one cannot count on the pressure-borne waters of the second northern water-bearing layer. The ground water in the majority of

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cases is salty, fresh water is found almost exclusively in the sands and can be used only for farm needs, especially for the watering of cattle. Principally, it is responsible for securing the sands by promoting vegetation.

The region for the supplying of artesian waters is found, evidently, in the north, i.e., in the zone where the syrt deposits are prevalent. N. I. Tikhonovich (440) says that the great pressure characteristic of the artesian waters of the Caspian deposits can be explained by the fact that they are supported by Neogene and Cretaceous waters circulating in the elevated regions and giving part of their waters to the Caspian strata coming into contact with them. He attributes their weak output to the fine-grained quality of the strata of the water-bearing layers.

The Pliocene deposits have a very great diffusion in the region on the left bank of the Volga, where they spread under the thicknesses of the syrt and Caspian deposits.

Little is known of the water-supplying of the Tirkary deposits left of the Volga, although at different times many boreholes were made. This is because of the lack of correct geological documentation of borings. As shown by F. P. Savarenskiy, borehole No 445 of the Volga Expeditionary Party passed through three water-supplying tables in the Pliocene. It is extremely probable that the Pliocene waters contained boreholes along the line of the Astrakhan Railway (Anisovka, Bezymyannaya, Nakhoy, Gmelinskaya, Pallasovka and other stations.) But a geological documentation of these boreholes was not made at an opportune time. Only afterwards did F. P. Savarenskiy give a hypothetical explanation of the fissures.

The boreholes at Anisovka and Gmelinskaya stations were found at the proposed thicknesses of the two Pliocene water-bearing layers, at

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a depth of 50 to 100 meters (the first layer at a depth of 40 meters at Anisovka Station and 68 meters at Chelinskaya, the second at a depth of 112 meters at Anisovka Station and 89 meters at Chelinskaya Station.) At Pallasovka Station the Neocene layer was found at a depth of 47 meters. The water usually has great pressure, lifting it 30 to 50 meters higher than the depth at which it emerges. The level of the water in the borehole at Chelinskaya Station is 25 meters, at the depth of emergence 63 meters (first layer), and 30 meters at a depth of emergence of eighty-nine meters (second layer). The quality of the water is unusually bad, because it is strongly mineralized.

To sum up contemporary knowledge of the water-supplying ability of the Tertiary deposits of the left bank of the Volga, F. P. Savarenskiy concludes that the Pliocene, spreading under the hill and Caspian deposits, does not have well-defined water-bearing layers, especially as regards fresh water. The question of the possibility of getting deep artesian waters in the region of the left bank of the Volga still has not been satisfactorily answered. The lack of deep boring in the region on the left bank of the Volga impedes the clarification of the geological structure of the deeper strata and the possibility of finding water-bearing layers in them; meanwhile the general scheme of structure of the left bank of the Volga allows us to hope that a considerable depth we may find water from the Mesozoic, Jurassic and Cretaceous strata as well as from the lower Tertiary strata of thick clay containing silica and the sandstones of the Syzran' and Saratov strata. B. A. Mozharovskiy (349) reckons this to be from 300 to 500 meters.

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4. The Activity of Underground Waters

One of the most important results of the activity of underground waters is their influence on relief. It is evidenced most frequently by means of landslides and sinkholes. Other appearances, like these, in a sufficient degree of development in the region of the lower Volga bring loss to national economy, concluding chiefly in a comparatively swift change in the ground's surface (settling, landslides, avalanches, cave-ins,) taking place right before the eyes of contemporary man. Such changes of the surface destructively influence all construction conducted on territory that is subject to these changes.

Landslides

The necessary conditions for the formation of a landslide on the shore of a river consist of the alternation of water-penetrated and water-resistant layers imbedded in the precipice of the shore and inclining toward the side of the precipice. The ground waters in such thicknesses fall into many water-bearing layers. The lightly mobile particles of the crumbly layers become even more mobile from an admixture of water and slide along the adjacent flatnesses of the water-penetrated on water-resistant layers. An especially favorable condition is the clayey composition of the water-resistant layer, the surface of which, soaked by water, aids the sliding of the mass lying above it.

Within the boundaries of the Nizhneye Povolzh'ye, landslides are most prevalent on the right shore of the Volga, beginning almost from its northern boundaries and ending at the Stalingrad region. The right bank of the Volga from the village of Undor to Ul'yanovsk, and a little lower, has been almost entirely subjected to these landslides. The geological conditions of these landslides are as follows: the lower

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part of the layers making up the shore are formed of flat black Neocomian clays, to a large extent not penetrated by water and occurring sometimes lower than the level of the Volga. The upper part of the shore consists of sandstone-clay layers which are water penetrated to varying degrees, and differently related to the freezing point of the water within them. Some strata form continuous water-bearing layers, abounding in springs; some even have a subsoil layer of mud. The upper thickness of the layers, in relation to the lower division of the Cretaceous system, has a general inclination toward the south and causes the main mass of landslides. But in the opinion of A. A. Yaroveskiy (76a), besides the described geological conditions, other local conditions operate jointly in the formation of landslides in Ul'yanovsk, the chief of these being the winter cycle of the upper layers of the ground waters. The continuous freezing of the soil in winter is characteristic of Ul'yanovsk, and as a result of this the springs are kept from emerging to the surface, so that the mass of water inclines toward the crumbly deposits of the shore which in the spring, when the upper crust of the ground thaws, aids the formation of landslides. Undoubtedly, capping, having as its aim the idea of giving the ground waters a chance to flow freely to the surface the year round, would aid in lessening the intensity of these occurrences.

The second best-known region of the Volga where landslides occur is in the region of Batraka Station, in the former Syzran' Yuezd. A geological cross-section of the shore from bottom to top has the following appearance: (1) limestones, distributed lower than the shore-line of the Volga; (2) fine-grained, clayey and micaceous sands of an unknown age; (3) lower Callovian clays of a dark color with streaks of siderite and limestone sandstones (a thickness of ten to twelve meters); (4) thin micaceous sands, alternating with streaks of clay (eight to ten meters); (5) oolite marl of the middle Callovian age (two meters); and (6) grey marlous clays of the Oxfordian, Kimeridgian and Portland stages (36 to

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38 meters). Higher along the sliding alternating strata of Portland shale clays and sandstones occur, and in addition marl of the Aquilanian (Akvilonskiy) stage. The shear-line of the Volga is found on the border between the second and third strata.

Two zones of landslides are observed in this region of landslides; one passes along the upper part of the slope and another in the lower. The lower zone is especially stable. Special investigations in the shore thickness of the layers have detected many water-bearing layers. The most important of these is the third stratum -- a thickness of Callovian calcareous sands, imbedded between lower Callovian pebble clay and middle Callovian oolite marl. The second layer is found higher, in the upper layers of the Jurassic. Besides this, an insignificant water-bearing layer is connected with the lower border of gray marlous clays (plastic stratum). Judging by the composition of the thickness, waters can circulate at times along these chief layers and can also circulate in other layers when certain conditions change. Support of this is given by the many flat slidings detected in the landslide masses during drilling.

Going further into the investigation of landslides at Vol'sk, we notice that the shores of the Volga from Kashpir to Vol'sk are formed of sandstone-clay layers. At Vol'sk they change to deposits of marl, with which landslides are associated.

Lower Cretaceous, upper Cretaceous, tertiary and post-Tertiary strata take part in the geologic structure of the region of Vol'sk. The lower chalk has in it flat black clays of a thickness greater than thirty meters. The surface of these clays is irregular and uneven, but in general they fall in the direction of the Volga. A thick layer of fissured chalk on the clays, is imbedded, which changes to post-Tertiary deposits nearer the river. The subterranean waters accumulate on the surface of the black clay. This is demonstrated by the emergence of

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springs when the clays make contact with water-penetrated strata but in the valley of the Volga and its tributaries. In this way, the folding of black clay in the direction of the Volga and the bedding of a water-bearing layer on it creates the fundamental conditions for the development of landslides. But the complexity of landslides along the Volga is furthered by the fact that the sliding mass is of fissured chalk. The process of landslides according to V. V. Bronnikov (554), is accompanied by a dissolution of the chalk, in conjunction with which the settling of the sliding mass takes place.

At Saratov large-scale landslides have developed on Sokolova Mountain. This mountain slopes down to the town and turns off steeply in the direction of the Volga. Landslides here drop in hilly masses, over which rise separate clods of earth, tree trunks, and ridges. The greatest landslide occurred in 1884, when the whole rim of the mountain tore itself from its base on the shore and slid into the Volga. Here, too, the cause of landslides is found in the conditions of geological structure and relief. Sokolova Mountain is composed of alternating strata of clays and sands, having water-bearing layers.

Landslides are very frequent below the village of Sosnovka where the shore is composed of upper-Cretaceous and Tertiary strata. Below are imbedded greenish Senoman sands; on them lie Turonian marls, striped thicknesses of Senonian clay layers with silica (opoka) and Tertiary deposits. As observed by Ye. V. Milanovskiy (346), between each pair of ravines falling into the Volga are found stripes of landslide cirque. The surface of fresh landslides is riddled with deep fissures and crevasses. Dislodged landslide masses often do not lie horizontally, but show great upheaval: they are tumbled in slanting folds, or broken into faults.

Enormous landslides have developed also below the village of Rannovka (on the slope of Mount Syrt), and also in a number of other places right up to Stalingrad, where the following deposits are found and

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determine the dislocation of the shore masses: 1) landslides of Caspian clays and in places of argillaceous clays, chiefly in places where they lean or strade along an inclined surface of the fundamental water-bearing layers, 2) landslides of chalky clays; the causes of landslides seem to be the gentle of the inclined bed of the base of the Caspian deposits and the wetting and distension of clayey thicknesses.

Landslides in the chalky clays, which are very frequent, owe their origin, evidently, to the waters of the sands of Yergeni, bedded on the surface of the clays, which penetrated the thickness of the clays and made conditions favorable for landslides. There is evidence that the high, steep banks in the chalky clays have an unstable character. The ability of chalky clays to stratify under erosion, the presence of thin lands and seams of sand can aid the penetration of the layer by amounts of water and cause not only the appearance of surface swelling, and, in general, deformations, together with increase in girth, but also can aggravate the possibility of landslides.

In addition to the above-mentioned regions of landslides, known for the magnitude of their upheaval, the literature of the Nizhneye Povolzh'ye brings to mind a number of landslides. The majority are concentrated on the right bank of the Volga and coincide with the places where the Jurassic and Cretaceous layers emerge. Landslides are also found along the shores of the Syrzan and other rivers. Frequently landslides of Cretaceous layers carry along the tertiary layer. The geologic conditions of these landslides have been little studied although the landslides are sometimes considerable. Besides the already described layers, landslides are also observed in other layers, but less frequently and on a smaller scale. For example, along the Lipovka River (a tributary of the Kondurcha) there are landslides of Permian strata and layers of the Tartar stage. In the region of Smyshlyayevka Station landslides have occurred in strata younger than the Cretaceous.

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Karst

Karst is found in regions containing thicknesses of limestone or gypsum layers which are gradually dissolved and are carried away by subterranean waters, circulating along their fissures. The layers most rich in limestones and gypsums for the Nizhneye Povolzh'ye are the Permian and anthracite, because the regions where these layers develop are very often the regions where karst is to be found.

Karst is fairly widespread in the region of Samarskaya Luka at the village of Pecherskoye, evidently the very name of the village is derived from the number of karst caves here. The older karst funnels which have already completed their growth and are partly filled in with round formations, can be seen in the upper parts of Zhiguli. In the opinion of some authors, some more or less permanent reservoirs of little significance, as for example, Lake Yelgushi at Samarskaya Luka, are such caves. A more widespread occurrence of karst is found along the Sok River in the region of the village Sergiyevka, a little higher along the river. Here in the majority of cases, regular funnels are found, since the layers of limestones are covered over with a layer of crumbly strata. Less well-defined karst funnels are found at the village of Alekseyevka on the right shore of the Samara. Karst is widespread in the region of Lake Baskunchak. It is created by dissolution of gypsum and crumbling of the roofs, forming hollows.

In conclusion, it is necessary to add that all karst occurrences observed in the Nizhneye Povolzh'ye present themselves in the majority of cases as stages which have reached sufficient development, and very often as old or extinguished stages.

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1. Precipitation, Snow Cover, and Evaporation

Precipitation

The overall pattern of the distribution of mean annual precipitation over the Nizhneye Povolzh'ye region is comparatively simple. The greatest amounts fall in the northwestern and northeastern parts of the area, with the centers of increased precipitation to be found beyond its borders. Furthermore, as shown on Map 39, there is a general trend in its distribution showing a considerable decrease from the northwest to the southeast. The surface of the land also slants in the same general direction. A vast lowland lies between the Urals and the Volga on one side, and the foothills of the Obshchiy Syrt and the Caspian shore on the other. Especially conspicuous on the background of this lowland is the bluff on the shores of the Volga itself, which has a raised right bank and a low-lying left bank. The great difference in the distribution of precipitation is connected with this characteristic orographic feature of the basin. There is little rainfall on the lowland, and it decreases almost in direct proportion to the distance from the raised bank of the Volga. At the same time the 2nd and 3rd isohyet lines, indicating a decrease in precipitation, remain almost parallel to the basic hypsometric line -- the right bank of the Volga and its continuation south of Stalingrad, namely the Yergeni. The northern part of the basin is built quite differently, and so is the corresponding arrangement of the isohyet lines. Between Saratov and the tip of Samarskaya Luka the higher elevations of the Volga ridge move somewhat to the west, away from the Volga, leaving east of the basic Gorodishche elevation a series of smaller ridges, going from south-

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west to northeast. It is along these ridges, ending at the Samarskaya Luka, that the centers of greater or lesser precipitation are rather capriciously located. Nevertheless, all of them, without exception, have greater amounts of precipitation in the northwest, and lesser in the southeast. The 350 millimeter isohyet line, indicated on the chart of isohyets, shows the demarcation line between the comparatively well irrigated northwestern part of the basin, and its eastern part, where there is little precipitation. This isohyet line can be traced over most of the basin, from Stalingrad to Saratov and Vol'sk, then somewhat to the south of Samara, approximately in the direction of Buguruslan, where, on the northeastern border of the basin, there is a considerable area of intensified precipitation, amounting in some places to 500 millimeters annually. Between the Volga, from Samara to Tetyushi and the above mentioned watershed of the Ik and Dema on the east and Cheremshan, Sok and Kinel' on the other side, there is a spot with little precipitation, which lies about the middle reaches of the Cheremshan. This lowland section with a low relief is also noted for a considerable decrease in the amount of precipitation. Both to the west and to the east the amount of precipitation increases. Evidently, we have here a clearly defined case of the dependence of precipitation on the orographic division by the shelf of the right bank ridges, centering along the right shore of the Volga.

The above outlines the general features of the direction of isohyets on charts of yearly distribution of precipitation as well as of its distribution during the warm season. It is interesting to look in detail at the course of annual isohyets of 350 and 400 millimeters over a small area in the valley of the Teroshka, one of the

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few right bank tributaries of the Volga, which phenomenon was already mentioned in ChapterI. An almost complete and independent repetition of the same curves on the chart of the warm season is sufficient proof of their general dependability, even though the area of these isohyets is very small. The chart of precipitation during the warm season discloses two interesting details -- an increase in precipitation along Samarskaya Luka, and a similar increase in the basin of the Yeruslan. Both of these projections, peculiar only to the warm season, are based on quite reliable data from a number of stations (for example: 7 stations for Samarskaya Luka).

The isohyets of the cold season do not give a well differentiated picture because of the generally small amount of precipitation at that time of the year. However, they also indicate the characteristic decline in precipitation towards the southeast and a concentration of comparatively great amounts to the north and northwest. One detail, however, deserves attention. In the central area, between Vol'sk and Buzuluk, the amount of precipitation is somewhat greater than in the adjoining areas. This fact was already noted on the graphs of annual rainfall for Vol'sk and Buzuluk in the survey of the general climatic map in Chapter I. This fact, together with the increased precipitation on the middle reaches of both Yuzen' Rivers in that season, permits the surmise about an increase in autumn-winter precipitation on the southern border of the Syrts. Probably this is due to an intensified condensation at the foot of the first ridges in the Syrt area, as well as those along the Volga. (This is a perfectly normal process, which is often observed in the autumn and early winter in locations with a moderate relief and reveals itself as a concentration of smoke in foothills and valley bottoms.)

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The attached table (see below) presents a summary of monthly, yearly and seasonal precipitation, with norms as shown alongside the minimum and maximum amounts. It can easily be seen that the maximum amounts exceed (in monthly means) the norms by 3 or 4 times; even the yearly amounts may be almost double the mean temperatures.

Drawing 80 presents a series of curves, indicating the yearly movement of the average and also the extreme amounts of precipitation, subdivided into solids and water. These curves are given to indicate the character of the annual course of precipitation in the various parts of the basin. The less precipitation there is at a given point, the greater are the variations liable to occur there. For example, in Astrakhan' and Malyy Uzen' the ratio between the maximum and average amounts in July reaches 500 percent, while further north, as for instance in Polibino, it is only 200 percent. By examining these curves, it is easy to trace the regularity in the distribution of greatest amounts during the separate months. At stations having a small observation cycle the movement of extreme amounts is almost parallel to the movement of the mean.

Further, the recurrence of the years rich and poor in precipitation is traced over the last 40 years as far as this is feasible, by making a survey of variations from the mean during each individual year. This survey has been made on the basis of a yearly mean only. These variations are shown on a separate graph (see below), and are expressed for convenience in percentages of the averages over several years. The same graph shows the mean temperatures figured for each year on the basis of observations of all the stations which functioned during that year. Not all the data is available for the entire 40-year period (and therefore the means for individual years are not equivalent), but nevertheless the results are of interest. They

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are summarized in the following table, where the data of the greatest and the smallest precipitation is given for the years which were most outstanding in that respect.

As it can be seen, out of the 40 years it was easy to choose 5 years when the precipitation was by 28 to 42 percent above the mean (which was observed over an area of more than 85 percent of the entire area of the basin), and also 5 arid years (when a deficiency of 21 to 32 percent below the mean was noted over the entire area). During the remaining 30 years the fluctuations were not so sharp. Apparently it is not by chance that years with much precipitation often follow one another, while the years with little precipitation occur singly.

Years	Percentage of stations with a precipitation over the norm.	Average excess of precipitation over norm	Years	Percentage of stations with a precipitation below the norm.	Average deficiency of precipitation below the norm.

In Chapter I we gave some information about the snow cover. Now we present some additional facts, specifically a graphic summary (see below) of the results of observations of 82 stations which operated within the territory under study and partly in adjacent areas. As regards the date when the snow cover reaches its greatest thickness, it should be noted that this date is subject to the greatest fluctuations not only throughout separate years, but also in adjoining stations. In the south, and especially in the neighborhood of the sea, it is especially variable, and, because here the snow melts and disappears much earlier than in the north, the snow cover has been found to be thickest as early as the middle of January

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(on the 15th in Biryuch'ya Kosa and in Yashkul'). Inversely, in the northern stations, where winter is harsher and more persistent, the snow cover reaches its maximum height only on the 25th of March. Thus the falling off and gradual thawing of the snow cover varies very widely (over 2½ months) depending upon the local conditions.

The figures representing the extremes of the average duration of the snow cover show a still greater divergence (within the limits of 72 days in the area of the Kuma River in the south to 161 days in the northeast, at Yekaterinovka and Russkiy Kandyz). This divergence reaches up to three months. It depends, of course, not only upon the latitude of a place, but to a considerable extent on its microclimate and on the conditions under which the snow-measuring rod is exposed, which we can not take into account. In any case the flow of water from the thawing snow in the north starts much later, at a time when the soil in the south could already be dry for a long while.

The information about the length of time it takes the snow cover to disappear is of interest. In the south, where this cover is not thick, it disappears very rapidly. On the average this process takes about 15-18 days (Urda, Khosheutovsky sector), while in the north it takes up to 59 days (Kozlovka and Kochkarley). Obviously the slow melting is attributable not only to thermal conditions but also to the amount of shade and cover. Variations of 10 days and more are observed at stations located close to each other. The rate of thawing is also dependent on these factors. In general this rate is not rapid in the northern part of the basin (usually from 0.5 to 1 millimeter in 24 hours), and increases considerably in protected wooded spots, where normal thawing is de-

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layed for some reason, as for instance on the Dmitriyevskiy Khutor, where the record rate for the entire basin - 2.1 millimeters in 24 hours - has been noted. In Chapter I we have already commented on the fact that some of the stations are in unusually shaded or wooded spots, which causes especially vigorous spring floods on the wooded sections of the rivers; also, that a small delay of 5 to 6 days in the thawing is offset by an increased speed of the process.

Polibino Kamyshin Stalingrad Malyy Uzen' Tinguta Astrakhan'

Diagram 90. Graph of the annual distribution of maximum, average and minimum monthly precipitation at some points on the Nizhneye Povolzh'ye.

The height of the snow cover is shown of the graph both in averages and in extremes. In its greatest absolutes it is over 1 and even 1.5 meters on Samarskaya Luka (Sosnovyy Solonets). Such a figure is unusual for the European part of the Soviet Union, and it is only in the Urals and very few other places that greater thicknesses have been noted. The average thickness is much less - in the north it may be estimated within the range of 40 to 60 centimeters, and in the south the average of the greatest measurements of thickness is from 20 to 40 centimeters. In general, the snow cover over the Nizhneye Povolzh'ye region is spread rather capriciously, which is to be expected in an area where a snow cover is not a normal phenomenon, not only because of its southern location, but also because of the instability of its climatic and air-pressure conditions. The Volga region is located on the edge of the area of two powerful anticyclonic systems, where there are frequent changes of winds of

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opposite directions, and therefore is subject to sharp changes of weather. Snowstorms and "sukhovets" (hot dry winds) do not contribute to the uniformity of climate, which would be expected from the proximity of the warmer Caspian Sea. Actually the Caspian Sea does little to improve the climate of the Nizhneye Povolzh'ye region. Its influence is felt only along the shores, and even so it is not always beneficial. On the shore itself there is a desert, in spite of the nearness of the sea. While in summer the Caspian Sea has a moderating effect on the temperatures, in winter it sometimes generates winter winds without snow, which are the reason for the low snowfall in winter and the instability of the snow cover all over the southern part of the Lower Volga basin.

The spring thawing varies greatly not only in different years, but also during the same season, depending on the setting and the geographical area. To illustrate this point we have chosen several cases of a more unusual type of gradual increase and sinking of the snow cover. The graphs (on Chart 91) have been compiled by decades on the basis of averages over a number of years. From the figures for Buguruslan, Bezenchuk, N. Kuvak and Sosnovyy Solonets, it can be seen that there are shrinkings and increases of the cover in the middle of winter, which are reflected even in the main figures; likewise, it does not subside evenly in spring. The basic factor to be considered is the thermal pattern, inasmuch as the drifting of snow caused by winds has a lesser and mostly local significance, and hardly affects the hydrological process.

Air Humidity

In order to study the question of moisture turnover in the basin it is necessary to consider the humidity of the air, as this

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is an important factor in the formation of precipitation as well as in evaporation. Until lately the only source of information on this subject was a treatise written by A. A. Kaminskiy in 1894 (045). This treatise gives information on absolute humidity for only 5 stations, and for an aggregate of 40 years. Then, quite recently, in the first issue of the Climatology Handbook of the GGO (1955) we found observations made at 8 stations. However, these are not given for individual years, but only in averages for several years. In the present case the facts about absolute humidity are not important of themselves, but only as a starting point for a computation of deficiency of saturation. Therefore, when writing this essay, we again performed the work of selecting and summarizing the figures on absolute humidity by months for all the years for which data was was available during the period from 1891 to 1930 inclusive. There proved to be 23 such stations within the basin,(and 10 more in the bordering areas), and their aggregate observations cover 365 years. A summary of this data is presented on a chart (page 462), as averages for the whole period.

This data has not been reduced to one period and is probably subject to future revisions, but is nevertheless valuable, as the most complete information on the Nizhneye Povolzh'ye area. When comparing it with the information given in the GGO Handbook we find some trifling discrepancies, unavoidable, because of the different years taken as basis. A general survey of this information indicates that from April to October, and on the seashore to November, the absolute humidity is usually over 5.0 millimeters, decreasing to 1.2 millimeters in winter in some sections of the basin. Its threshold values exceed the indicated lower limit by three times in summer (Biryuch'ya Kosa - 15.6 and Chetyrekhbugornyy Mayak 16.7 millimeters), while in

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the central part of the area, along the Yuzen' rivers, this increase amounts to only 200 percent. Thus the figures confirm once more the great humidity of the Caspian shore in comparison to the inner portion of the area, where the Malyy Uzen' has the highest absolute humidity in July of only 10.5 and Novouzensk 10.6, while in the south the Chetyrekhbugornyy Mayak and Biryuch'ya Kosa have 15.7 and 15.6 respectively. Moving north from the Uzen' rivers we find a rapid increase in humidity: Vol'sk and Timashevo have 12.9 and Polibino 12.1.

Buguruslan — Bezenchuk

Novyy Kuvak — Sosnovyy Solonets

Maximum — Average — Minimum

Chart 91. Graphs of the increase and decrease of the snow cover for some places of the Nizhneye Povolzh'ye area (according to averages over several years).

Deficiency in Saturation

The measurements of this factor, given below, are the result of summarizing simultaneous data on absolute humidity in relation to temperature and wind velocity for each year, by individual months. It is not often that observations of all the three component elements are reliable. It was necessary, therefore, to compile them by years, and it proved impossible to achieve a strict synchronization of data for the entire area. It also proved that short series of deficiency in saturation are comparatively unreliable, because of the considerable range of their variations, and the great variability of the three elements entering into the computations. It was therefore necessary to limit ourselves to the possible reduction of separate observations

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to those made over a number of years, but we did not succeed in reducing them all to one period. For the sake of clarity and for a correct estimation of the magnitude of fluctuations on the chart (see below) we give the extreme figures in addition to the average figures over several years, by months and by stations, where observations have been made for over 10 years.

When studying the deficiency in saturation, it is customary to take only the averages, and often these averages are not figured for the individual years, but for several years at once, in a simplified way. Such figures are acceptable only for the winter months, when the very fact of deficiency of saturation has no vital importance. However, it is in no case permissible to use for comparison data taken over less than 7 - 10 years, and, even less so, to use figures over a 2 - 3 year period, unless these figures happen to coincide in their scheme of temperature and humidity. The figures on the graph confirm this statement very convincingly.

The greatest range of variations occurs during the summer months, as for instance, in July, which can be illustrated by the following figures:

	Maximum	Minimum	Mean	Range	Deviation from mean in percent
Astrakhan'					
Akhtuba					
Malyy Uzen'					

These extremes increase in the north relative to the distance from the sea.

	Maximum	Minimum	Mean	Range	Deviation from mean in percent
Kostychevskaya					
Saratov					

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Ul'yanovsk

Dereveye Lesnichestvo

The results presented in this table have already been partly examined in Chapter I of the Handbook and presented on Maps 15,16 and 17. Both the yearly and the maximum amounts on the table persistently and consistently outline the area of the middle and lower reaches of the Bol'shoy and Malyy Uzen' rivers as the area of the highest indicatives of deficiency in saturation. With a yearly maximum over 4.5 millimeters it is necessary to look for the yearly averages of deficiency in saturation over a wide belt, bound by two almost parallel lines, going from the northeast to the southwest through Malyy Uzen' and Stalingrad in the north and Astrakhan' and Gur'yev in the south, as shown on Map 15.

The deficiency in saturation decreases rapidly, in proportion to the distance from the sea, which shows that the sea has hardly any effect on the yearly indicators for the entire country. To the north of the designated area there is a falling off of the deficiency, not so pronounced, however, as in the approach to the sea. Also, there is a noticeable difference in this respect as in all others between the right and left banks of the Volga; the more complex pattern of the isolines between Saratov and Syzran' is evidently caused by the more complex structure of this area of the Volga. Beyond Samarskaya Luka and upon emerging into a more orographically calm area between the Kinel' and the Kama, the isolines are distributed more evenly.

Map 16, showing the distribution of deficiency in saturation degrees during the summer period presents a more complicated and abrupt pattern. The maximum is located in the undrained area of both Uzen' rivers and the Gor'kaya River. One has to look east beyond the Urals for a continuation of this area. Its southern border passes to

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the south of the Kamyah-Samara lakes in the Ryn' sands region. The moderating influence of the sea does not extend beyond 100-100 kilometers from its shores. To the north of this area of maximum deficiency in saturation, the quantities decrease, again presenting a series of conflicting isolines in the area between Saratov and Syzran' and repeating the pattern of transition to a more even distribution of quantities in the northernmost section of the basin.

Map 17 presents the distribution of deficiency in saturation during July on the basis of averages over many years; this shows that its amounts are the highest for the whole European part of the USSR. This map as well as the preceding one indicates clearly that the roots of this phenomenon are in Asia, in the vast Central-Asiatic deserts. The phenomenon seen in Europe represents only their westernmost spur. Maps 16 and 17 give a complete picture of the penetration to the west of the areas of greatest aridity under the combined influence of the Siberian winter maximum pressure area and the summer Azov maximum pressure area in relation to the Persian-Afghan minimum. The above information on the deficiency in saturation represents a substantial addition to the general climatic pattern of the basin, according to Keppen's classification (see Chapter I), especially as regards that portion of the basin on which little light has been thrown heretofore. On the basis of these facts additional subdivisions of the desert area presented on Map 5 are demonstrated.

Evaporation

The following material has been compiled on the subject of evaporation: total and diffused evaporation for 24 stations has been computed according to Meyer's formula; data on evaporation for 10 stations has been collected according to observations of Wilde's

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(Vil'd) evaporator. More detailed tables are shown on page 403. At present only general comparisons are given. The months from April to October inclusive are accepted as the warm season, and November to March inclusive, as the cold. The smallest amount of evaporation within one year, 80 to 88 centimeters, is observed in Polibino and Ul'yanovsk. The stations Vyrypayevka and Spasskoye, situated slightly more to the north, show 102 centimeters already. Evidently, local features and geographical conditions are the cause of this difference of 20 percent. Accepting an average deviation of 10 centimeters, we conclude that the yearly amount of evaporation in the central and northernmost sections of the basin is 93 centimeters, which is almost twice the amount of precipitation.

In the central part of the basin we find stations where the amounts of evaporation differ greatly. If we divide these stations into two groups we will find, among those where the evaporation is small, Vol'sk (95 centimeters), Syzran' (91 centimeters), Timashevo (91 centimeters), and those with large amounts - Saratov (134 centimeters), Pereschuk (122 centimeters), and Buzuluk (125 centimeters). We obtain a mean of 91 centimeters for the first group, and 122 centimeters for the second, or an over-all mean for this section of the basin of 108 centimeters, with an average deviation of 15 centimeters (14 percent).

Further south we find the following two groups: Kochetkovo and Kamyshin - with little evaporation, and Kostychevskoye and Malyy Uzen' - with much. As a result we get an average evaporation figure of 131 centimeters, 11 centimeters or about 8 percent.

The maritime section has likewise two representative groups - Oranzhereynyy Promysel and Biryuch'ya Kosa with an evaporation of from 106 to 119 centimeters, and on the other hand, Akhtuba and

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from 49 percent to 80 percent of the evaporation figures arrived at by using the formula, namely:

At Malyy Uzen' during one year 61 percent; during the warm season 57 percent.

Kostychevskaya

Oranzhereynyy Promysel

Biryuch'ya Kosa

Kochetkovo

Astrakhan'

Polibino

These figures confirm the unsuitability of Wilde's (Vil'd) evaporator because of the unforeseable defects resulting from its being mounted sometimes in an open booth, at other times in a booth closed to the winds, according to local conditions, and moreover under artificial temperatures, which do not correspond to the temperatures of the water's surface. It should also be noted here that one cannot attach too much weight to Meyer's formula. It gives certain approximations but not the absolute amounts of evaporation.

/Caption to Chart/

Nizhneye Povolzh'ye. Yearly evaporation according to Meyer's formula.

Very little attention has so far been paid to the annual progress of evaporation. The attached diagram (Figure 83) presents the annual progress of evaporation arrived at according to Meyer's Formula for 8 stations, only one of which, Novouzensk, is located in an open semi-desert and not on the Volga (it is indicated by a dotted line on the chart). All the other stations are on the shores of the Volga; they are listed from north to south. The course of evaporation

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Chetyrekhbugornyy Mayak with figures of 101 and 146 centimeters, which result in an average of 132 centimeters, with a mean deviation of ±17 centimeters, or about 13 percent.

Name of Station	Evaporation according to Meyer				Evaporation according to Wilde (Vil'd)		
	Year	Warm Period	Cold Period	Diffused Evaporation	Wind Evaporation	Year	Warm Period	Cold Period
Kamyshin								
Stalingrad								
Vol'sk								
Saratov								
Malyy Uzen'								
Kostychevskaya								
Akhtuba								
Oranzhereynyy Promysel								
Chetyrekhbugornyy Mayak								
Biryuch'ya Kosa								
Spasskoye Experimental Field								
Ul'yanovsk								
Vyrypayevka								
Syzran'								
Kochetkovo								
Bezenchuk								
Yershov								
Novouzensk								
Astrakhan'								
Timashevo								

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Timashev Kolok

Polibino

Borovoye Lesnichestvo

Buzuluk

Tintuga

Boasta

When examining more closely the results of a comparison of all four groups, we have to admit that the least dependable figures are those of the 2nd and 4th groups, which show only one half the normal deviation. This range of deviation is justified by the local conditions - considerable diversity in the topography in the 2nd group, and the extremes of maritime influences in the 4th. The 1st and 3rd groups are free from these drawbacks. If that is so, then we can accept 93 centimeters for the northern part, 108 centimeters for the central belt, and lastly, 131 centimeters for the entire south, starting with Yeruslan and the Irgiz-Uzen' watershed.

A comparison with the yearly amounts of precipitation shows the following results:

Average amount of precipitation	in the 1st area	in the 2nd area	in the 3rd area	in the 4th area
	40 centimeters	35 centimeters	25 centimeters	22 centimeters
Average amount of Evaporation	93 centimeters	108 centimeters	131 centimeters	132 centimeters

The sharpest break in the prevalence of evaporation over precipitation is noticeable with the shift over the border of the Syrt elevations to the lowlands. It is to be remembered, however, that Meyer's formula gives only the approximate theoretical figures, and

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that these figures apply to the surface of small bodies of water, but not to rivers and large lakes. Therefore, in practice, the numerical ratio of precipitation and evaporation will differ from the above figures. However, in the absence of better data these figures are undoubtedly useful.

A comparison of data on evaporation during the cold and warm seasons indicates that winter evaporation is insignificant compared to the summer evaporation, as it represents only 3 to 5 percent of the total amount of evaporated water.

According to the facts shown on the table on page 64%, the function of wind in relation to evaporation is much more important and complex. It is difficult to set it up in definite graphs, as apparently it depends entirely upon local conditions and upon the exposure of the wind vane. In the Syrt valleys the share of evaporation attributable to wind represents in extreme cases (Borovoye Lesnichestvo) about 50 percent of the evaporation by diffusion, or one third of the total evaporation. It is somewhat less in Vol'sk and Syzran', where valley influences are not so pronounced. At many stations both portions of the evaporation reach 50 percent each, and in completely open sections, as for instance the Chetyrekhbugornyy Mayak, the share of the wind evaporation is by 15 percent higher than that of diffusion evaporation, as it is to be expected.

Thus the influence of wind has a substantial effect on the increase in evaporation.

There is a certain relationship between the above mentioned facts and the problem of comparability of data on evaporation arrived at according to formula with those obtained from Wilde (Vil'd) evaporators. A comparison of both series shows the following results. Evaporation figures according to Wilde (Vil'd) represent

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is quite regular, but the greatest amounts fall on different dates, with variations up to 2 months. The length of the period of greatest evaporation is also variable. The earliest maximum falls on the

Spasskoye
Ul'yanovsk
Saratov
Novouzensk
Stalingrad
Akhtuba
Astrakhan'
Chetyrekhbugornyy Mayak

Figure 92. Graph of the annual progress of evaporation for some locations of the Nizhneye Povolzh'ye.

first ten days of June; a very short maximum period occurs at Spasskoye Experimental Field, located almost at the estuary of the Kama, which, during thespring floods, brings into the Volga system its own microclimatic influence. Further down, the dates of the maximum evaporation fall somewhat later, and the maximum period itself becomes less definite with the gradual shifting south to Saratov, where it occurs about 40 days later than in Spasskoye. Going further we find a further change of the annual progress near Stalingrad and a considerable blunting of the curve and shifting of the maximum period in the area between Akhtuba and Astrakhan', where the spring floods of the Volga are especially pronounced and last till July and later. The Chetyrekhbugornyy Mayak on the shore itself has the latest maximum period.

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Doubtless the peculiarities indicated above follow on the progress of the spring floods of the Volga, and can be explained to a great extent by the powerful influence of the spring floods. The curve of evaporation at Novousensk is much more symmetrical, and confirms the above by its simple and regular shape, as it is formed under the influence of only the thermal factor, and not through the combined effects of both the temperature of the air and the hydrothermics of the Volga.

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2. Drainage

a. Drainage in the Volga Basin

Preliminary Hydrometric Data

The first hydrometric work in the north part of the left-bank Volga region was started in 1879 when the Navigation Descriptive Commission of the former Ministry for Ways of Communications (MPS) opened two water measuring stations on the Samara River. Later, in addition to that performed by the Ministry for Ways of Communication, hydrometric work was carried on along the basin of this river by the local offices of the Ministry of Agriculture, and after the Revolution by the People's Commissariat for Agriculture of the RSFSR. During the recent years of 1930-32 much hydrometric work has been conducted by the Electric Power Project. Up to very recent times the research work has been primarily concerned with the measuring of the water level and only since 1930 has work commenced on the establishment of hydrometric stations.

In the southern part of the left-bank Volga region, hydrometric work was started in 1903. Irrigation expeditions were conducted in the Caucasus and South Russia by a number of organizations, frequently working with long interruptions, such as: the Hydrotechnical Section of the former Novouzensk Zemstvo, the former Saratov Land Council, the Second Volga Expeditionary Party OZU, the Volga Colonization Expedition, Kraydortrans, Rupvod, Reclamation Department of the Volga German ASSR, UIZ, and, during recent years, Giprovod and Lower Volga Project. From the very start the purpose of this research was to determine the extent of water resources.

The greatest development has been achieved during recent years, particularly during 1931-32 when the greatest number of hydrometric

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stations to date were simultaneously operating throughout the entire territory.

It is necessary to stress the complete lack of system of the organizations which have in the past conducted this research. Having started observations at one place, the work would soon come to a halt, and, if renewed, would start in another locality. The result of the situation was that there appeared to be a large number of stations, but they rarely made observations over a period of as long as 5-6 years, most of the observations were of 1-2 years' duration. This fact makes the observations of little value and also makes it difficult to use the results.

From the tremendous quantity of material which has been accumulating over many years of research, it is possible to obtain at present mostly post-revolutionary material, most of this material already being in a completed state in the form of appendices to manuscripts, a smaller quantity in original form, and, finally, a very insignificant quantity of published papers. In characterizing this material it is necessary to note the following faults. Water measuring observations and measurements of water discharge even on rivers having year-round run-off, was carried out with few exceptions only during the period of thaw. Furthermore the measurements were started after the run-off had begun, and concluded before it had ended. The observations very frequently lack information about ice phases. The distribution of many hydrometric stations at the tributaries of the main river, especially of the Volga, or in the vicinity of dams, makes it not only difficult, but frequently impossible, to calculate the discharge. Furthermore a serious fault is the inaccuracy of water run-off figures, calculated in most cases by the use of floats, while before the Revolution this work was done by gradient

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(slope), inaccuracy in calculation of discharge in the vicinity of water reservoirs, the resulting difficulty in calculation through natural wide water by-passes, marked changes in the river bed, resulting in the necessity of constructing curves of run-off for every year.

The fundamental difficulties encountered in calculating the discharge is caused by the nature of the rivers in the left-bank Volga region. These rivers are characterized by fast moving waters during the thaw period which lasts only for a short period, great variations in the water level and, consequently, depth, the occurrence of wide flood plains, movement of ice masses frequently during the peak flood period. All these serve as detrimental factors even to the present day for the correct measurement of current velocities by means of the more accurate instruments -- such as the water-current meter (vertushka). During ice movements one has to resort to the only possible method of measuring the current by observation of the movement of ice blocks. The float method of measuring speed can give fairly accurate results, however it requires the knowledge of the coefficient for correcting the surface speed to that of the average for the cross section. In working over the material pertaining to the left-bank Volga region this coefficient was usually accepted as .80-.85, and the relation of the maximum speed of surface current to that of the average as .67. The experimental confirmation of these coefficients for the left-bank Volga region are known only at certain localities (Malyy Uzen'-Malouzensk, Bol'shoy Karaman-Mariental' and Malyy Karaman-Baoro in 1929) and have yielded coefficients which do not contradict the ones mentioned above. However, these experiments do not provide the basis for assuming the correctness of the above coefficients which have been confirmed only in general and must be regarded as an approximation requiring further confirmation.

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The similar revision of material has been conducted recently by the Lower Volga Project. The following paper is based on this work.

Without stopping to discuss the working out of each point separately it is necessary to mention certain general principles. Curves for water expenditure, as a rule, were constructed graphically separately for each year. The individual figures of run-off were analyzed in chronological order and in those instances where they were grouped into several branches, there was constructed a train (schleife) of curves. The run-offs measured during movement of ice were not considered in preparing the curves and the discharge was calculated directly from measured expenditures. In some instances for a large number of measured expenditures, when the necessity for interpolation fell off, the discharge was calculated directly from measured expenditures. The extrapolation of time for the beginning of the discharge (in the absence of observation) was corrected by daily average temperatures of the air. The beginning of discharge was accepted as the moment of transition of average daily temperature across zero degrees. The calculation of the winter discharge for the Samara River at Maksimovka was conducted by means of the summer curve and coefficient $K = \frac{Q\ winter}{Q\ summer}$, determined from date of the immediate changes. The average value of this coefficient was accepted as .45. At other points the winter drainage was calculated directly from measured expenditures. Computation of the discharge was carried out according to the hydrologic year, the beginning of which was accepted as 1 October. Despite the large amount of work that has been conducted, the resulting data for discharge of rivers of the left-bank Volga region must be regarded as more or less approximate, requiring further corrections which may be accomplished by the collection of new and more accurate data.

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The General Conditions of Discharge in the Volga Region

The physical-geographic characteristics of the left-bank Volga region are quite varied. By moving towards the south and southeast, there occurs a rapid change of the geographic landscape in a relatively sh rt distance. The change is from forest-steppe in the north to dry steppe bordering on sand-desert in the south. However, despite the varied natural conditions, the main factor for the entire territory as regards discharge, incorporating its size and its variation in time and space, is the climate.

The character of discharge is determined in general by the sharp continental climate of the Volga region with its cold prolonged winter, stormy sudden onset of spring, and hot and very dry summer. The discharge of thawing snow waters is the predominant form of discharge in opposition to all other forms of annual discharge both from a point of total effect as well as the maximum flow per second with the exception of very small areas. This is particularly true in the southern parts of the left-bank Volga region, where the spring discharge essentially represents the entire year's discharge. Basically the discharge of thawed snow depends upon the quantity of accumulated snow at the time of thaw and in some years also depends upon the spr ng rains. The rains, however, because of its insignificant quantity cannot have a special influence on the matter.

In addition to the above, fall rains are of considerable significance especially in connection with soil-geological condition of the syrt (hilly) part and as such determine the extent of infiltration during the following winter and spring periods.

The condition of the surface of the ground at the time of being covered by snow, the number of winter warm spells, and intensity of spring

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thaw play a significant role in the syrt part of the left-bank Volga region only when there is very little moisture in the fall, when the soil is covered by a net of cracks caused by the marked parching of the earth during the preceding summer period. Otherwise, the effect of syrt clays when damp to spread out and fill in the cracks reduces the influence of these factors, as the syrt clays belong to the semi-permeable group. The thermal cycle during the winter and fall-spring periods is of considerable significance in the other parts of the left-bank Volga area, as well as in the right-bank Volga belt of sandy syrts, with wide ravines and elevations leading up to the ravines which have topsoils and subsoils of greater permeability, although in the northern part it is partial and mitigated by a more broken-up relief. The losses due to evaporation during the fall-winter period are relatively small and are approximately the same for the entire territory.

Thus, having in mind that the amount of snow, fall and spring rainfall, temperature, topography, etc., changes from south to southeast and, in addition in the direction of a negative influence on the size of spring discharge, it is natural to expect in this connection a reduction in the size of the latter. High temperatures and a great deficiency of moisture during the summer period are factors which are not conducive to the development at such a time of surface discharge. The highly dried-out and perforated network of fissures in the topsoil and subsoil greedily absorb the falling moisture, which at the end of the rainfall does not have time to soak in sufficiently deeply, and is again evaporated into the atmosphere. In such conditions, especially in the southern part of the left-bank Volga, the run-off of rainfall precipitation is almost absent. Only in the case of a very damp summer or fall, when the soil does not possess such a tremendous absorptive capacity,

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is surface run-off possible, though, in a small measure. In the most northern part, where climatic conditions are less sudden and where the topography is more broken up, summer flood drainage happens more often, but also within restricted limits.

Regarding ground drainage, its extent and spatial distribution is closely connected with the geological structure. Ground drainage in more or less significant measure is found only in the northern and northeastern parts of the left bank of the Volga -- in localities of Permian limestone marl strata and significantly lesser degree on the slopes of Obshchiy Syrt, with folded Jurassic, Cretaceous and Paleocene strata. In a region of widespread slightly permeable post-Tertiary syrt clay elevations, which attain a thickness of 50 meters, ground drainage is absent, with the exception of individual localized sections. Therefore, rivers which flow in this region, from the very beginning of summer are broken up into separate stretches of water, partly natural, partly artificial, held back by dams. Ground drainage here is to be observed for separate portions of the rivers where the latter reveal sandy levels of syrt strata (at 3-4 points on the Bol'shoy Uzen', at Yeruslan below D'yakovka) or in places where there are outcroppings of ancient rocks of the Permian axes of the left-bank Volga region (at Bol'shoy Kushum, Bol'shoy Irgiz near Pugachev, on the lower reaches of the Chagry and Mocha). In general, ground drainage of the left bank Volga is negligible and flows in the same direction as spring drainage, that is, to the south and southeast.

From the foregoing it follows that the physical-geographical peculiarities of the left-bank Volga region are such that in contributing to the turbulent drainage of melted snow waters as opposed to other aspects of yearly drainage, they result in great irregularity in the

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dr inage during the year because most of the water runs off during the short spring period, while the discharge is either insignificant or entirely absent for the rest of the year.

The second characteristic peculiarity of the drainage, in connection with the geographical situation of the left bank of the Volga at the border of the chernozem zone, is the great variability of the drainage from year to year. The lower limit of this variability reaches its extreme in the southern part of the left-bank Volga region. In extremely dry years, the drainage here is so negligible that it is hardly sufficient to fill up ponds and streams (pools), as was seen, for example, in the years 1 28-30.

Average Yearly Drainage

The yearly drainages of the rivers of the left bank of the Volga not having inspired special doubts in their accuracy and the circumstances at the basis of further conclusions, are shown in the table (pages 170-171 of original text). It should be noted that certain of the data contained in the table chiefly relating to the southern part of the left bank of the Volga, are understatements, inasmuch as the absence of pertinent information does not permit the calculation of the quantity of drainage held back by small dams, a significant number of which are situated at the upper parts of ravines and to a lesser degree on the rivers. It is easy to observe that for a number of localities as large as 30, the total number of years of observation is only 60, that is an average of less than 3 years for each locality. The longest observed period on drainage is for the Bol'shoy Uzen' near Novouzensk, which covers a period of 11 years. From the table it is seen that the discharges of the remaining rivers, with individual exceptions, follow sufficiently well the fluctuations of the discharge of Bol'shoy Uzen'

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and, consequently the data for that river may be used for the characteristics of the water during the observed period.

The average layer of discharge for the 11-year period at that point was 44 millimeters, and the average for the consecutive 9-year series was 42 millimeters, that is, approximately the same. In relation to this average, the years 1919-20, 1925-26, 1926-27, and 1931-32 were years with abundant water, the years 1928-29 and 1930-31 were near the average, and the years 1918-19, 1923-24, 1924-25, 1927-28 and especially 1930-31 were years of drought. As regards the question to what extent the average layer of discharge for the observed period approaches long-term averages, one may assume that the average discharge for that period is near the standard, because the 9-year period consists of a number of years differing in amounts of water. Indirect confirmation for what has been said is to be found in the data of the investigations of the State Hydrological Institute, according to which the spring floods of 1929 and 1931 on the Bol'shoy Uzen' were in the category of the mean. On the basis of these considerations it is possible to estimate close to the average volume of discharge for a continous number of observations on the Solonaya Kuba River (for 8 years) and on the Irshib-Moguta Estuary (for 6 years). At the remaining points on the left bank of the Volga the rates of discharge were determined by comparison with the discharge of the Bol'shoy Uzen'.

Norms plotted in this way on a map were found to be quite regularly distributed over the map, making possible spatial interpolation. Orientation with respect to these points, allowing for local physical geographical conditions, made it possible to draw isolines of discharge, as depicted on the attached map. It should be mentioned that there were included points with only a single year's observation, which were adjusted,

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however, approximately to the norm by means of a module coefficient.

For plotting isolines in the northwestern and northern parts of the left-bank Volga region where factual data were lacking, as well as for tying in the ends, there were used maps of isolines of the mean module of flow for the Middle Volga region as compiled by D. L. Sokolovskiy, for the Don basin as compiled by L. V. Polyakov, for the Ural basin as compiled by P. P. Kokino, and for the European part of the USSR as compiled by B. I. Kocherin (2439). A map drawn up in this manner gives only a general scheme of the extent of the flow of the left-bank Volga territory. Margins of error from 15 to 20 percent of the mean flow are possible for small basins, caused by purely local physico-geographical peculiarities.

The territory of the left-bank Volga region is included between the isolines of 1.0-3.0 liters per day (l/s). The isolines in the southern part have the general northwestern direction characteristic of the left-bank Volga, which gives out in the north under the influence of the Ural range, with the isolines taking on an arched shape, the concavity of which is turned to the north. In general the flow falls toward the south and southeast, i.e., with changes in the same direction as the climatic factors bringing it about.

Having in mind the range of accuracy of the initial data used in plotting this map, the briefness of the observations, the method used in adjusting them to the norm, as well as the rough character of the isolines in the northern and northwestern parts, for which no factual data was available, it must be looked upon as a preliminary work in need of additional efforts to make it more accurate.

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TABLE OF ANNUAL DRAINAGE AND NORM OF DISCHARGE FOR THE LEFT-BANK VOLGA REGION

Number	River	Place	Area of the Basin in kilometers	Layer of flow in millimeters: 1887/88	1916/17	1917/18	1918/19	1919/20	1920/21	1921/22	1922/23	1923/24	1924/25	1925/26	1926/27	1927/28	1928/29	1929/30	1930/31	1931/32	Norm: Millimeters	Norm: Liters per day(1/s) per square kilometer
	Bol'shoy Uzen'	Novouzensk																				
	Altata	Osinov-Gay																				
	Malyy Uzen'	Petropavlovka																				
	Malyy Uzen'	Malyy Uzen'																				
	Yeruslan	Konstantinovka																				
	Yeruslan	Langenfel'd																				
	Yeruslan	Krasnyy Kut																				
	Yeruslan	Ekgeym																				
	Yeruslan	Visenmiller																				
	Yeruslan	Poltavka																				
	Gnadentavskiy Liman	Gnadentau																				
	Solenaya Kuba	Valuyki																				
	Elementarnye Vodosbory	Valuyki																				
	Bol'shoy Karaman	Romanovka																				
	Bol'shoy Karaman	Marientel'																				
	Bol'shoy Karaman	Krutoyarovka																				

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Malyy Karaman	Nosro
Limany	Prishib-Koruta
Bol'shoy Irgiz	Koverino
Bol'shoy Irgiz	Glushitsa
Bol'shoy Irgiz	Klevenka
Bol'shoy Irgiz	Malaya Rykovka
Kamelik	Novo-Spasskoye
Bol'shoy Kushum	Novo-Bel'kovka
Malyy Irgiz	Seleznikha
Samara	Maksimovka
Buzuluk	Andreyevka
Buzuluk	Kondaurovka
Tananik	Rodionovka

(1) The areas of the basins of the Malyy Uzen', Yeruslan, Bol'shoy and Malyy Karaman, Bol'shoy Kushum, and Bol'shoy Uzen' below Altata are determined from a map of the Volga G.K. on a scale of 1:84,000; the Bol'shoy Uzen' above Kamelik, the Malyy Irgiz, the Bol'shoy Irgiz, according to a 1932 map by Giprovod on a scale of 1: 420,000; the remaining rivers according to a VTU map on a scale of 1:420,000.

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Variations of Discharge Along the Courses of Rivers

Factual data which would make it possible to draw conclusions regarding variations of discharge along the courses of rivers are, unfortunately, almost non-existent. Therefore the question can only be elucidated in broad strokes on the basis of isoline maps of the mean moduli of discharge and the physical-geographical peculiarities of the individual sections of the left-bank Volga region. Looking at this map, it is easy to see that on the rivers which flow north to south, the absolute discharge along the courses of the rivers increases, but the relative must decrease. On rivers flowing in an opposite direction, both the absolute and the relative discharge increases along their courses. In the region of the Caspian Lowlands, as a result of the loss of water through a river (Bol'shoy and Malyy Uzen') the absolute flow along the river also falls. In addition to this, the fall of the absolute discharge along the river can also be explained by the action of water-retaining structures (dams, side channels, etc.) which are located everywhere.

A peculiarity found here resulting from the geological structure of individual sectors of the left-bank Volga regions, is the appearance of discharge in the lower reaches of rivers (Yeruslan above D'yakovka, Bol'shoy Irgiz at Pugachev, and others) during the summer when no flow is observed in the upper reaches of these rivers, and, on the other hand, the disappearance of discharge along rivers like the Altata, Chizhaldi, and others.

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6. The Ice Cover and Ground Ice on Rivers

Thickness of the Ice

Extending south to north more than 1,500 kilometers, the Lower Volga region falls into individual sections under different climatic conditions, which considerably influence the character of the ice on the rivers. In addition to being located in lower latitudes, the southern part of the region is in the winter under the warming influence of the Caspian Sea. And the northern part is partially cut off by the forest-and-steppe belt, which also has a certain influence on the character of the ice. Along with climatic peculiarities, an important role in determining the distribution of ice thickness on the rivers is played by topographic differences of individual parts of the Nizhneye Povolzh'ye.

Observations of ice thickness on the rivers of district were for the most part obtained by questionnaires sent to correspondents in the places. Unfortunately, a considerable part of the material is only for one or two years of observation.

Observations are cited on the table on page 488 [of the original text] with the data representing short-term observations in italics. Along with the estimated mean maximum yearly ice thickness at each of the observation points, the table includes the smallest and largest yearly maximum ice thicknesses on the rivers. The data cited in the table is drawn in on the map (Figure 96).

On the map appear a number of patches with different ice thicknesses, which are designated in three sections: less than 50 centimeters, from 50 to 75 centimeters, and more than 75 centimeters. The northern part is more diverse in this respect, evidently because of the short observation period (which means that chance factors may be significant),

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and because the topography of the northern part is more broken up, as compared with the remaining territory. The broken up topography of the region is a factor in the unequal distribution of the snow cover, which directly influences the thickness of the ice. In marking on the map the boundaries of this or that patch designating a general area of the thickness of the ice cover on the rivers, not only numerical data, but the topography of the district was also considered.

The dependence of the growth of ice cover on the latitude of the locality, which has been observed here with respect to lakes, is entirely absent for rivers. This is evidently because the ice cover is formed

Caspian Sea

Ice Cover Greater Than 75 Centimeters

Ice Cover 50 to 75 Centimeters

Ice Cover Less Than 50 Centimeters

Figure 96. Schematic map of the distribution of ice thickness on the rivers of the Nizhneye Povolzh'ye.

later on the rivers than on the lakes, toward which time the warming influence of the Caspian Sea is felt throughout the southern part of the district. On the other hand, the snow cover is considerably greater in the more northern districts by the time the rivers freeze over, than at the time the lakes freeze. In the southern districts of the region, the snow cover is considerably thinner than in the northern districts. This

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explains the absence of a noticeable increase in thickness of the cover as one proceeds further north. Patches with a uniform thickness are seen in more northern districts as well as in the more southern. On the other hand, there are a number of cases on the map in which, on the same river, places with entirely different ice thicknesses are comparatively close together. These cases, of course, can be first of all explained by the limited number of observations made, and particularly by the fact that these observations were made at different times.

October November December January February March April

Figure 97. Graph of ice thickness on the Volga at Tolyushi

During certain years, the ice cover for some of the rivers of the northern part of Nizhneye Povolzh'ye reaches a thickness of 100 centimeters or more. The range of maximum thickness of the ice in certain years becomes very great for many rivers. For instance, on the Volga at Astrakhan', the average maximum thickness of the ice for a period of 49 years (1827-1867, 1870-1875, and 1926-1930) was 56 centimeters. The thickest ice was 107 centimeters (24 January 1930), while the thinnest was 28 centimeters (February 1871).

Considerably more variation in the thickness of the ice is observed for the small rivers. On the Samara, for instance, at the village of Sorochinsk, from 1926 to 1930, the average maximum thickness of ice was 69 centimeters. The largest of the maximum annual measurements over this same period was 120 centimeters, and the smallest was 9 centimeters. Such variations in ice thickness in a brief series of observations occur,

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of course, because of changes in air temperature during the winter periods, though it is possible that the snow cover had some influence.

In the accompanying graphs (Figures 27 and 28), the growth of the ice cover is shown at the village of Tetyushi and at Dubovskaya Station, both on the Volga. (Both the graphs and the accompanying texts have been taken from the draft copy of the notes of N. N. Sokolov for the Okrug Administration for Volga Shipping, in the archives of the State Hydrological Institute). Moreover, for the Oranzhereynyy Promysel at the mouth of the Volga, measurements are given below, showing the build-up of ice during the winter months for 1912 (see following table).

For the village of Tetyushi, there are observations covering a five-year period, for Dubovskaya Station only one year, and for Oranzhereynyy Promysel, for only three months. The insufficient frequency of observations is reflected in the graphs by the angular lines, and sharp jumps which evidently are not characteristic of the actual conditions. On both graphs, the initial notations do not coincide with zero thickness of the ice. This happens because the usual ice cover is established on rivers after there already is a thick layer of slush or sludge ice.

Months	January	February	March
Number			
Thickness of the Ice in Centimeters			

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N. N. Sokolov considers four phases in the fluctuations in the thickness of the ice along the Volga: (a) increase in growth during the beginning of the winter, (b) winter growth, ending with the maximum cold weather, (c) the period of lessened rate of increase and the end of growth, and (d) diminution of the ice cover, prior to the break-up. The growth of the ice cover at the beginning of the winter is distinguished for a certain rapidity. In this regard, it is usual in cases when winter comes late, for the ice to gain during this period at the rate of 10 to 18 centimeters a day. The thickness increases rapidly, up to a definite thickness which depends upon the climatic conditions of the locality (at Tetyushi, from 53 to 60 centimeters, and at Dubovskaya from 35 to 43 centimeters). A thick layer of ice protects the water from freezing weather, which, however, is of short duration, only a small increase in the thickness of the ice is to be noted.

At the end of the winter, the ice continues to grow very slowly and only during periods of the coldest freezing weather. It is at this time that the ice reaches its maximum thickness. At the village of Tetyushi, the average maximum thickness reached by the ice is 77 centimeters (with a range of variations from 83 to 64 centimeters). At Dubovskaya Station, during the winter of 1914-1915, the maximum strength of ice reached 43 centimeters. At Oranzhereynyy Promysel, it was 24 centimeters. The time of maximum ice thickness ordinarily corresponds with the moment that the spring thaw sets in. The fourth phase is a decreasing thickness in the ice, under the influence of the spring thaw. Accurate data on the amount by which the thickness of the ice decreases before the beginning of the break-up is not available. It would appear however, that during this thawing period, the strength of the ice diminished to two-thirds or three-fourths of its maximum thickness.

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It is of interest to watch for the moment when the ice is at its thickest along the river, over a more or less prolonged period of time. Such data are available for the Volga at Astrakhan', for the period from 1 27 to 1867 (Zarubin, 1041). The mean date for the beginning of the maximum thickness of the ice, comes on 12 February. In 34 percent of the cases sampled, the maximum thickness of the ice was noted in January, with 44 percent of the cases in February, and only 21 percent of them in March. The earliest beginning of maximum ice thickness was noted on 1 January 1856, and the latest on 29 March 1832.

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(k) DEEP GROUND FREEZE

Deep ground freeze is characterized by the depth to which zero temperatures descend as well as by the depth of the layer in which ice crystals are formed. The level of normal winter ice formation descends to a shallower depth than the subzero temperature level, but observations of ice formation in the ground have hitherto been of a more or less sporadic nature in our study of deep ground freeze, so that we shall have to be content with data on the depth of the latter level. These data are available for only 12 stations in the Lower Povolzh'e, and at that, for different periods, which makes any comparison between them rather unpromising.

The table on the following page shows the dates of first and last ground freeze, the number of days elapsing between first and last ground freeze, and the average number of days with temperatures of zero and below. From an inspection of the table the fairly regular progress of deep ground freeze from north to south will be noted both by their first and last occurrences and by their average duration.

The first surface freezes are observed at the end of September in the north of the Kray and the beginning of October in the south. The last surface freezes are observed during the latter half of April in the south, and during the last days of May in the north. The average number of days with temperatures of zero and below on the surface of the ground ranges from 178 in the north to 132 in the south. In the first half of October subzero ground temperatures descend in the north to a level 0.1 meters below the surface, and reach the same level in the south during the latter half of October. During these periods the average number of days with temperatures of zero

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and below at this level is 156 in the north and about 100 in the south.

The penetration of the subzero temperature level to deeper layers of the ground proceeds with fairly uniform lags both in the north and in the south. Thus, temperatures of zero and below reach a ground depth of 0.25 meters during the first half of November in the north and during the early part of December in the south, with the average number of days with temperatures of zero and below at this level being 139 in the north and about 85 in the south.

Subzero temperatures penetrate to a ground depth of 0.5 meters during the first half of December in the north and the second half of December in the south, with corresponding average duration at this level of 118 and 57 days, respectively(22 days at Bekmukhammad Tent Station) and to a ground depth of 1.0 meters during January in the north of the Kray and during February in the south, with corresponding periods of 88 and 16 days.

Observations on ground layers deeper than 1.0 meters have been made only at the Stalingrad station, and here, at a depth of 1.6 meters, the first freeze took place on February 22 and the last one on March 16, with average duration of subzero temperatures at this level 16 days.

Thawing of the ground proceeds more uniformly than freezing, and the last temperatures of zero and below were observed at all depths during April in the north and during March in the south. Throughout the territory of the Kray, later freezing in depth at the beginning of the cold season and earlier thawing at the end of this season occurs not only because of difference in latitude but also, to a considerable extent, because of the influence of the Caspian Sea.

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It should be noted in studying this table that the average number of days elapsing between the dates of the first and last freezes is greater than the average number of days with temperatures of zero and below. This difference is explained by the occurrence of thaws during the period after the first freeze and before the last one. Juxtaposition of the two latter graphs will show the number of thaw days for each of the depths in the table.

The average and extreme ground depths to which the level of zero and subzero temperatures descends is shown by Table II.

TABLE I

AVERAGE DURATION OF SUBZERO TEMPERATURE AT DIFFERENT GROUND DEPTHS

Name of Station	Coordinates Long.	Lat.	Elevation above Sea level	Years observed	Depth in Centimeters	First Freeze Earliest	First Freeze Average	Last Freeze Earliest	Last Freeze Average	Average number of days between first and last freezes	Average number of days with zero and subzero temperatures
Buguruslan											
Buzuluksko, field station											
Danilovka (Petrovskoye field station)											
Nikolayevsk (Saratov)											
Kochetkovo (Kamyshlak)											
Krasnyy Kut											
Malyy Uzen (river)											
Kostychev Agricultural Field Station											
Kamyshin, nursery											
Stalingrad											
Khosheutov Area											
Bekmukhammed, tent											

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TABLE II

DEPTH OF PENETRATION OF ZERO TEMPERATURE LEVEL INTO THE GROUND

(BY MONTHS)

Name of Station	Years Observed	Nature of data (max., min.)	Average Maximum and Minimum Depths in Centimeters Sept Oct Nov Dec Jan Feb Mar Apr May	Depth of Thermometer in Centimeters
Tupuruslan				
Yeusulukskoe Field Station,				
Danilovka (Petrovskoye Field Station)				
Nikolayevskaya (Saratov)				
Kochetkovo (Kamyshin)				
Krasnyy Kut,				
Maliy Uzen'				
Kostychekov Station,				
Kamyshin nursery				
Stalingrad				
Khosheutov Area				
Pekmukhammed Tent				

(Text continues on page 519)

For a number of stations where the lower limit of depth lay deeper than the level of the soil thermometers, it was necessary to limit the data to the extreme values for depth of freeze.

It is interesting to note that the average depth of ground freeze is almost the same at the Nikolayevsk and Stalingrad stations - 154 and 155 centimeters, respectively - though the latter is almost three degrees further to the south. Obviously, a role is played here by the snow cover, which is thicker and more lasting in the north and serves to protect the ground from freezing in depth. The Kamyshin station, for instance, which lies halfway between Nikolay-

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evsk and Stalingrad, has an average depth of ground freeze at only 78 centimeters, which is consid rably lower. This is explained by its location in the middle of a block of cultivated forest about 200 hectares in extent, which provides shelter from the wind and thus aids in the formation of a deep, flocculent snow cover. [Evidently there is some confusion: number of days with temperatures to and including zero is not the same as number of days with subzero temperatures excluding zero, at any level, unless there are no readings of zero at all. Yet in this section they seem to be used interchangeably.]

4. GENERAL HYDRO-CHEMICAL SKETCH OF THE OWER VOLZHI'E.

General Data

The vast plain, almost 200,000 square kilometers in area, which the Volga divides into two parts - southwestern and northeastern - is known by the name of Aral-Caspian Lowlands. On the west this plain is bounded by the Yergeni Highlands, on the northeast it extends to the Kyn'-sands, passes over into a plain of salt lakes and stretches out as far as the spurs of the Great Syrt. The shore belt of the Volga itself (and this is especially true of the eastern bank) is a tangled labyrinth of numerous parallel branches, outlet channels (yerik) and creeks. A chain of elongated lakes and il'men extends along both banks. The waters of the Volga, of its branches and other formations, and of the lakes and il'men in its vicinity, are freash, but these lakes (il'men) which are further away on the west and east, not being freshened by the waters of the Volga, represent all stages of the transition from mild salinity to the status of full salt lakes. Consequently all the aqueous

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formations that depend on the Volga hydrologically are intimately connected with it hydrochemically as well. The greater the distance from the Volga, the more do the chemical properties of, and processes in, surface and ground waters come under the influence of geological conditions.

The general slope of the lowlands toward the sea, the fan-shaped arrangement of the dunes, radiating from it like spokes of a wheel, the fine silt and sands left by the receding sea, and the numberless salt lakes -- all these speak of the relatively close, broad expanse of the Caspian Sea. The greatest number of these salt lakes is distributed over the expanses to the east of the Volga. One of the largest natural salt lakes in the world is located in the north of this expanse - Lake Altun; another lake - Lake Baskunchak - second only to Lake Altun in size - lies to the south of it, at the base of Mount Bogdo. There are a number of other lakes in the area between them and to the east, at the edge of the Ryn'-sands. Still further east, from the shores of the Caspian to the lower reaches of the Great and Little Uzen' Rivers, there are numberless lakes and ponds, presumably left behind by the retreating sea. Not only is salt found here in the lakes, but it also permeates all the soil of the salty steppe, and, leached by the atmospheric water out of the heights and dunes, it passes into the depressions, adding to the abundance of water and salt in the existing lakes or forming new ones. Even the best khuduki yield saline or alkaline water. This immense and almost inexhaustible amount of salt on all of the expanse we have been discussing has remained here as a result of the presence of the sea on this territory in former geological epochs. Marine deposits have also left their vivid stamp upon the hydrochemistry of the whole Lower Povolzh'e, except the Volga itself and the narrow belts along its banks.

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After setting apart as a special zone the belt formed by the Volga River itself, all the remaining area of the Lower Povolzh'e may be subdivided into the following hydrochemical zones, going north from the shores of the Caspian Sea:

(1) The Aral-Caspian salty clay-sand steppe, with numerous salt lakes, salt marshes and solonetzes.

(2) The chernozem-clay wormwood and wormwood-feathergrass steppe, with smaller areas of residual lakes and salt-marshes.

(3) The chernozem region, where oak and linden forests (and, on sandy soils, pine woods) alternate with belts of feathergrass steppe.

The Zone of the Volga Itself

The composition and concentration of the salts in the waters of the Volga, and the whole complex picture of salt conditions there, are influenced by two main factors: the climate and geological characteristics of the whole southern lowland region of the Volga approaches, and to a considerably lesser extent, the make-up and character of the rocks which lie under the upper strata, serving together as the runoff area for the region. The high temperatures and the prevailing north and northeast dry winds lend an emphatically continental character to the climate of the Bray. Especially in the southern part, the region may be included among the dry, desert areas, in spite of the proximity of the sea, and it has all the physical-geographical peculiarities of such areas, including the principal one: a considerable excess of evaporation over condensation and inflow of water. Surface and ground waters lose more water than they receive, and consequently the concentration of their dissolved salts rises to such an extent, under favorable circumstances, that some of these substances begin to be pre-

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cipitated out of solution and new combinations begin to appear in the salt take-up. This process is rather marked in all the small tributaries of the Volga, and to an even greater degree in all the surface waters that form their own individual basins in the region; but it is only slightly noticeable in the waters of the Volga itself. The quantity of water is too great, and the period during which a unit volume of mainstream water traverses semi-desert and desert zones is too short. The position of the river in the surrounding landscape - a position created by the geological past - serves in even greater measure to safeguard its waters from salinification. Thanks to this fact, the main stream of the river and its broad floodplain exhibit hydrographic differences from the adjoining areas.

In consequence of the continuing fall in the level of the ancient Caspian Sea, and of the drainage of its shallower areas as a result its waters began to be concentrated in the deeper parts of the trough represented primarily by the lands on the western approaches to the Volga in the region under discussion. The recession of the sea proceeded from east to west and caused a gradual constriction of this inlet, and only after a considerable subsequent fall in the level of the sea did the recession begin to proceed from north to south. The rivers and streams emptying into this area carried their waters and contributed their clastic material, and most of this constricted inlet became deepened and assumed the character of a broad, smoothly flowing river, while other parts of it passed through the stages of liman and delta. On top of the marine deposits freshwater sand and clay-silt deposits were laid down. At the same time the older deposits of the ancient Caspian basin were energetically undermined and washed away in the area of the constricted inlet and of that part of

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the older sea-bottom which was just beginning to re-emerge from beneath the inlet level. After the final recession of the Caspian, this constricted inlet became the Volga; and the present Volga valley probably follows the deepest parts of that ancient inlet. This deposition of thick strata of freshwater sand-clay alluvia particularly favored the delta-forming expansion of the mouth of the river further and ever further into the sea. This same process of growth and gradual lengthening of the delta was characteristic also of other rivers of the region, but to a lesser extent than in the case of the Volga. At last, after the final recession of the sea from this inlet, and, in consequence, the lowering of the erosional base, the Volga and other streams began to undercut and wash away their own alluvial deposits, considerably deepening the channel and forming a terrace above the meadow. And to this day the deposition of alluvia on the Caspian littoral and the Volga delta still continues, forming liman, cutting off lakes on the approaches to the river and the sea, relocating the shore line of the sea by moving it southward, and so on.

In general, this whole process formed a tract of land completely different from all the rest of the expanse, that begins at the present littoral of the Caspian and extends to the northern end of the Lower Povolzh'e. The Volga carries its waters into the Caspian Sea, after leaving its freshwater alluvial deposits, in almost the same stage of mineralization that those same waters had when they entered the Oblast. Even in the Caspian itself, the river still pursues its course for dozens of kilometers, separate and distinct from the surrounding waters of the sea. But even though the total quantity of mineral substances in the waters changes but little during their transport from the northern boundary of the region down to the very moment of entrance into the sea, the composition of these salts does never-

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theless undergo a very significant change, as has been shown in Chapter III (pages 215-227).

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The Zone of Silty Clay-Sand (Lake) Steppe

On the left bank of the Volga this zone extends from the shores of the Caspian to the line joining Lake Gor'kaye and Lake Altun with the Kamynh-Samara lake chain. On the right bank it also begins at the shores of the Caspian, and runs approximately as far as the southern lakes of the Caspin chain. Salinity is at a maximum throughout the entire zone, both in the surface waters and ground waters, and there is a very high degree of distribution of lake formations without outlet. A considerable proportion of these steppe lakes is temporary in character and entirely dependent upon precipitation. Whether directly or indirectly, actively or passively, the sea played a part in the formation of these lakes, and still plays a part to this day. These lakes may be divided into two classes, according to the two principal methods of formation: (1) residual, and (2) continental. The first class represents the remaining fragments of the primeval Aral-Caspian Sea, while the second class represents the accumulation of precipitated waters, in a trough or depression, after enrichment in salts by leaching out the more elevated steppe sand-clay soils, impregnated with salts since the recession of the sea. A very important role is played in the formation of lakes of the first class by the marine inundations, or kultuk; and liman, or, as they are called, "coastal il'men" are formed from them. The process of formation is as follows: on the littoral, low-lying areas of the steppe - troughs and ravines - empty into the sea. In spring and autumn and, in general, in rainy weather,

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these depressions fill with fresh water, which flows in a broad stream into the sea, transporting sand and silt along with it. The sand and silt can be carried away by the waves or blown away by the wind. The ravine is thus turned into an inlet of the sea - a kultuk or zaton, as the local inhabitants call it. This inlet, formed in one way or another, does not remain unchanged. Its mouth begins to silt up from the action of the waves and the shore backwash. The wave of the sea, drawing silt and sand with it, meets the wave returning from the shore, or the current of steppe water bearing silt, and little by little forms a belt of deposited earth at the mouth of the kultuk. This belt grows in width and height and emerges from under the water. This stage of formation of a new pool is mostly called aiman. The deposit which separates the new basin from the sea seldom takes the form of a single unbroken belt; most often it has an outlet, girlo, or, as the aboriginal natives call it, banki. The separation or enclosure of considerable saline parts of the sea may also occur without the activity of fresh coastal water, when the receding waves meet the transverse currents of the sea that parallel the shoreline.

If the inflow from drainage and the additions from atmospheric water are not great, the salt concentration in the il'men begins to rise. At first the sea, maintaining its connection with the liman through the girlo, pours in an abundance of rapidly evaporating water, thus increasing the salt concentrations more and more. But even subsequently, when direct contact has ceased, its communication with the liman (il'men) is not interrupted. In this second stage, when it has no more direct inflow to the liman, the sea seeps in through the intervening deposited barrier, and slowly but constantly supplied its salt water to the interior pool. This new seepage evaporates again and again, and turns into a heavy brine, or rapa.

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The truth of this story of how these numerous lakes of the Caspian zone came to be formed is demonstrated by present-day phenomena: before our eyes the formation of inlets proceeds on the Caspian shore, then the deposition of the alluvial barriers and the separation of the highly concentrated salt lakes from the sea.

But not all the salt lakes scattered about on the steppes of the Caspian littoral are of this origin. A large number of lakes in the Astrakhan area, farther from the sea, were formed by the leaching of salt-bearing steppe heights by water from precipitation. Rain waters and snow waters pass through the salt-impregnated layers of the soil and subsoil, dissolving and washing out the salt. Flowing from the elevations of the salt steppe, they form saline lakes at first, which, enriched in salt content from year to year, then become concentrated salt lakes. The present-day appearance of new lakes and the changes in the composition of the waters in the old ones confirm this view of the origin of a large number of Astrakhan-area lakes. Increased intake of salts occasionally turns such lakes into bitterns, owing to the accumulation of magnesium and sodium sulphates, but in a few years they become saturated again with sodium chloride and begin to deposit it in thick layers.

The inexhaustible wealth of such lakes as Altun and Baskunchak is explained by the fact that the concentrated salt they contain has been washed out of the original deposits of rock salt and transported to a new location, where it joins the flow of residual steppe salt from the stocks laid down in the days of the Aral-Caspian Sea.

The difference between these two lakes, both in the qualities of their brine and the composition of the dissolved salts, doubtless depends upon the nature of the salts extracted from the subsoil.

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Lake Altun is nearer to the sea-type of lake, while Lake Baskunchak more closely approaches the continental type. More detailed chemical investigation of the large number of lakes in the Astrakhan area may make it possible to distinguish their various differing characteristics and - the principal task - may allow us to distinguish between the residual and mainland (continental) lakes and also all the transitional stages between these two types.

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1. WATERWAYS AND WATER TRANSPORTATION

(a) Navigation on the main body of the Volga

Conditions of Navigation

The Volga with its tributaries occupies an exclusive place in the system of waterways of the USSR. The largest river in Europe, it carries, together with its tributaries, 46-48 percent of the whole freightage of inland waterway traffic in the Soviet Union. The Volga basin has acquired great significance from the point of view of inland water transportation because it has within its orbit such important economic regions of the Soviet Union as Severnyy Kray, Zapadnaya, Moskovskaya, and Ivanovskaya Oblasts, Gor'kovskiy Kray, Sverdlovskaya Oblast, Srednc-Volzhskiy, Saratovskiy and Stalingradskiy Kraya.

The total number of navigable rivers for that section of the Volga stretching from Rybinsk to Astrakhan', including all tributaries except the Kama and Oka, with their branches and side channels, equals 104 as listed by the Volga Administration for River Transport (VURT). The total navigable length of the rivers for powered and floatable vessels or rafts is 7,661 kilometers, while the navigable length for only floatable rafts is 5,878 kilometers. At the present time 6,151 kilometers of this length are being used.

On the territory of Nizhneye Povolzh'ye (within the limits of this book), besides the Volga itself, which has a navigable length of 1,735 kilometers from the confluence of the Kama to Astrakhan', the following tributaries were in use during 1930, 1931, and 1932: the Mayna (for a length of 18 kilometers), Usa (30 kilometers), Sok (30 kilometers), Samara (76 kilometers), Mocha (22 kilometers), Bol'shoy Irgiz (278 kilometers), the Akhtuba branch (114 kilometers) and the Buzan branch (48 kilometers) -- in all 616 kilometers. Manage-

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ment of navigation and maintenance of the waterway in the bounds of the region consists of four regional administrations of VURT, namely: that of Samara (under whose jurisdiction lies the region of the Volga from the mouth of the Kama to Khvalynsk), that of Saratov (from Khvalynsk to Kamyshin), that of Stalingrad (from Kamyshin to Vladimirovka), and that of Astrakhan' (from Vladimirovka to the mouth).

The main reason for not making use for navigation of the remaining rivers found in this territory is chiefly, aside from their lack of importance, their shallowness during the summer. The majority of tributaries of the Volga with floatable and powered navigation which are sufficiently deep in the springtime, become too shallow during the summer for even the smallest vessels. A general deficiency of the tributaries is the obstruction of the route by the presence of submerged logs, especially on the rivers which float timber rafts.

The chief obstruction to navigation of the Volga itself is the presence of a great number of sand shoals. The region from the mouth of the Kama to Marksshtadt, a length of 748 kilometers, has 55 sand shoals, and that from Marksshtadt to Astrakhan', a length of 987 kilometers, has 84. The great number of sand shoals reflects especially heavily on navigation in years when there is little water, chiefly during the summer, for they decrease the cargo loads of vessels and the navigability of the river. Therefore, in order to get depths required for navigation it is necessary to conduct yearly dredgings, clearing of the bottom, planing, and other corrective and hydrotechnical work. Expenditures for maintenance of waterways for the entire Volga Administration for River Transport are given in the following table for the years 1930 and 1931.

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Type of Outlay	Expenditures in Rubles 1930	1931
General costs (wages, fleet, materials, amortization, etc.)	1,507,292	2,262,792
Dredging (fleet, surveying, amortization, etc.)	5,225,062	6,700,422
Cleaning the bottom (fleet, crew maintenance, amortization, etc.)	288,201	249,002
Hydrotechnical work (wages, repair, materials, amortization, etc.)	154,302	195,525
Other work (ship hoisting, diving, sounding stations, amortization, etc.)	375,073	342,663
Total Expenditure for Maintenance of Waterway	7,540,020	9,730,462
Per kilometer of navigable waterway	1,490 rubles, 51 kopeks	1,888 rubles, 41 kopeks

The greater part of the expenditures goes for dredging work, which is conducted chiefly during the summer, starting in the beginning of June. In the last years dredging has been conducted only on the Volga itself, and not at all on the tributaries.

Accurate dredging of the channel on Nizhneye Povolzh'ye was first started in 1909. Until 1917 the former Kazan' Okrug had a navigable depth up to 2 meters. The ground on the Nizhneye Volga is sandy and fine-grained. The bed is extremely mobile. Sand shoals emerge from below the high waters in different conditions. Thus, sand shoals which present great impediments to navigation and require much dredging one year are in good condition and do not require dredging the following year. Some sand shoals persist for

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many years, then disappear, and new ones arise. Dredging takes place at approaches to wharfs as well as along the channel. Dredging of the channel begins at the spring ebb of the water, as soon as the machines are in a position to reach the bottom of the sand shoals with their buckets and pumps. Depending on the construction of the Volga apparatus, this is possible at a depth of 3.00 to 6.20 meters for sand shoals, since the frame of the apparatus can be lowered from 3.20 to 6.20 meters. The normal width of the cuts varies from 60 to 75 meters.

The total volume of the excavation for 1931 was estimated at 11,211,674 cubic meters, the total length of cuts in 1930 was 102,619 meters, and in 1931, 190,854 meters; the total volume of cuts for 1930 was 11,022,600 square meters, and for 1931, 11,348,816 square meters. The smallest depth gotten by dredging is as follows:

	1930	1931
	(centimeters)	
For the stretch from the confluence of the Kama to Kalymir	250	225
For the stretch from Kalymir to Marksshtadt	250	225
For the stretch from Marksshtadt to Astrakhan'	250	200

The highest exploitable velocity of the Volga current in 1931 during spring waters was observed at Bakhilovka (1,620 kilometers from the mouth) and was equal to 1.67 meters per second; in this same place the highest exploitable velocity of the water during the dry period in the summer was found to be 0.53 meters per second.

The total number of dredging apparatus working for VUKT in

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1930 and 1931 was 25. Surveying parties for the year 1930 amounted to 15, for the year 1931 to 18. The total length of measurements taken by them in 1930 was 25,000 kilometers and in 1931, 20,170 kilometers. The sand shoals which presented the most difficulty to navigation in 1931 are given in the following list, with a notation of the quantity of excavation done on each.

The Stretch from Dalymir to Markashtadt

1. Dalymir	123,161 cubic meters
2. Sergiyev	105,160
3. Bol'shoy Leninskiy	42,975
4. Novyy Baktyazhskiy	32,766
5. Podval'	36,526
6. V(erkhniy) Bakhilovskiy	83,608
7. Shiryayevskiy	80,159
8. Ryazan'	316,207
9. Perevolok	65,310
10. Kostychev	74,136
11. Syzranskiy Vodnyy Uzel	85,044
12. Vasil'yevskiy	108,615
13. Lukhovnitskiye	68,261

25 sand shoals in all were excavated on this stretch.

The Stretch from Markashtadt to Astrakhan'

1. Beklemishevskiye	164,608
2. Babonovskiy	172,276
3. Cherebayevskiy	36,761
4. Shcherbakovskiy	48,665
5. Kurnayevskiy	85,184
6. Pady	129,675

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7. Kyporosnyy	84,842 cubic meters
8. Beketovskiye	80,118
9. Sarepta	136,757
10. Shishkinskiye	100,904
11. Solono-zaymishche	59,325
12. Prishib	134,542
13. Kapitanskiy	71,296
14. Selitryanyy	51,040

18 sand shoals in all were excavated on this stretch.

The rivers of the Volga basin are very clogged and require clearing of their beds. Work is conducted on the tributaries in the same manner as it is conducted on the Volga.

Corrective and hydrotechnical work makes up only an insignificant percentage of the total expenditures of VUkT (in 1930 0.2 percent, in 1931 0.2 percent). Work is conducted on the tributaries in the same manner as on the Volga. It is necessary to mention that among the largest corrective projects on the Volga is the reinforcing of the right bank of the Samara River. In recent years the clearing of the channel andapproach to the wharfs of Saratov and Stalingrad has been the basic problem in corrective work.

The navigation aspects of the rivers, relating to extent, character, and length of navigable periods, is tied up each year with the work demands of the fleet, and consequently varies in accordance with the volume of the cargo, the areas of the fleet's operation, hydrologic conditions, and so on. In general, during the past 4 years the extent of the activity of the Volga Administration has increased annually although it still has not been

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able to completely satisfy the demands of increased traffic.

River navigation within the limits of the region for the years 1930 to 1931, has included besides the Volga the following tributaries: Mayna, Sok, Mocha, Bol'shoy Irgiz, and the following branches: Akhtuba, Buzan, and many secondary passages and channels of the Volga. The length of navigable period for these rivers is given in the table [on page 543 of the original text.]

The total length navigable waterways in the region consisted of 1,883 kilometers in 1930 and 1,856 kilometers in 1931.

The actual duration of navigation for 1922-1931 at different points of the Volga is given in the table below:

Place Name	Length of Navigation Periods, in Days									
	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
Confluence of the Kama										
Samara										
Saratov										
Stalingrad										
Astrakhan'										

On the Nizhnyaya Volga there are 2 railway bridges: at Ul'yanovsk and Syzran'. The bridge at Ul'yanovsk is newly constructed, with a span of 160 meters and a clearance of 14.30 meters from the lowest girders to the highest water level, does not present a serious impediment to navigation. However, the bridge at Syzran' (formerly Aleksandrovsk), which

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is an old bridge, with a span of 106 meters and a clearance of 12.95 meters for its lowest girders is extremely hazardous. The question of reconstructing this bridge, which is unable to withstand the new heavy locomotives has already been placed on priority.

The Fleet

In 1931 the fleet working for MMT consisted of 2,775 units, divided into categories given in the table below.

Type of Fleet	Number of Units	Total Horsepower, Freight Capacity or Length in Linear Meters
A. Transport Fleet		
Freight-passenger diesel steamers		
Tugboats		
Total		
Iron dry-freight non-powered carriers		
Wooden dry-freight non-powered carriers		
Iron oil-carrying non-powered carriers		
Wooden petroleum-carrying non-powered carriers		
Total		
B. Technical Fleet		
Dredging apparatus		
River bottom clearing dredgers		
Steamships, motor boats, outboard motor boats		
Fire boats, scows, etc.		
Total		
C. Emergency and Maintenance Fleet		
Steamships and motor launches		
Non-powered vessels, in tons		
Non-powered vessels, in linear meters		
Total		
D. Stationary Vessels		
Debarkaders and pontoons		
Docks		
Total		

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Note: hp horsepower
t tons
m meters

Freight-passenger diesel steamers belonging to VUST have different basic sizes, freight capacity and passenger capacity, depending on the region in which they are sailing. The power capacity of diesel steamers operating on the stretch from Gor'kiy to Astrakhan' varies from 600 to 1,200 indicated horsepower, the passenger capacity from 436 to 1,200 persons and the freight capacity from 275 to 975 tons. The largest steamer is 82 meters long, and 65 [illegible]7 meters wide, and the deepest draft is 2.3 centimeters. Local freight and passenger trips are made on ships of 16 to 350 horsepower. Steamer Number 3 (35 horsepower) operates on the Bol'shoy Irgiz River, from the confluence to Pugachev; the steamer "Lubovka" (100 horsepower, freight capacity 40 tons, passenger capacity 150 persons) operates on the Akhtuba branch from Leninsk to Krasnyy Yar. The steamer "Ural" (300 horsepower, freight capacity 145 tons and passenger capacity 409 persons) operates from Stalingrad to Leninsk.

Most of the tugboats used by VUST are 42.6 to 64 meters long and 6.4 to 9.6 meters wide. The most powerful tugboats (300 to 900 indicated horsepower) are used to pull petroleum barges. Most of them have from 400 to 600 horsepower. The barges which pull dry freight have from 36 to 280 indicated horsepower. Most of them have from 150 to 200 indicated horsepower. Harbor tugboats have 40 to 130 indicated horsepower.

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Name of Waterway and Limits of Operating Sectors	1930			1931		
	Category	Length, in Kilometers	Period of Operation, in Months	Category	Length, in Kilometers	Period of Operation, in Months

1. Samara Regional Administration

Volga: Confluence of the Kayna to Khvalynsk

Kayna: Gryaznykha to the Confluence

Sok: Krasnyy Yar to the Confluence

Mocha: Chapayevsk to the Confluence

Secondary passages and Channels on the Volga

2. Saratov Regional Administration

Volga: Khvalynsk to Kamyshin

Bol'shoy Irgiz: Pugachev to the Confluence

Secondary Passages and Channels on the Volga

3. Stalingrad Regional Administration

Volga: Kamyshin to Vladimirovka

Akhtuba: source to Leninsk

Leninsk to Kapustin Yar

Secondary Passages and Channels on the Volga

4. Astrakhan' Regional Administration

Volga: Vladimirovka to Streletskaya Vataga

Buzan: Source to Krasnyy Yar

Secondary Passages and Channels on the Volga

Remarks: Condition of Category I 24-hour watch and illumination

Condition of Category II Only illumination

Condition of Category III Without illumination

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The non-powered part of the fleet of the Volga basin can be divided into two types of barges. The first type is characterized by diametrical and flanged girders with solid b lting. The second type does not have diametrical or flanged girders. Their bolting is less solid (chiefly, cotter pins and nails). They are further distinguished from barges of the first type by the blunt outline of their end sections and their small decks. Barges of the solid-bolt type predominate in the Volga basin. Of these, the oil barges are the biggest in size. The composition of the oil fleet was as follows in 1930:

Measurements of Barges in Meters	Capacity in Tons	Number
Various Sizes	Less than 3000	

Of the total number of 209 oil barges used in 1930 there were 192 made of iron and 17 of wood. The total tonnage of the whole oil fleet in 1930 was 7,125,h00 tons. Vessels carrying dark products comprised 1,00h,173 tons of the total tonnage; 2[illegible] ships carrying kerosene comprised 10[illegible],h62 tons of the total; and 11 ships carrying oil comprised 16,025 tons of the total.

Dry freight barges, light barges, and semi-barges are used on the Volga and its tributaries to carry bread, salt, metals, and other kinds of dry freight. Most of the dry freight barges are wooden, 7 percent of the total number being made of iron. Dry freight barges are 50 to 100 meters long and 10.7 to 17.1 meters wide. Their freight capacity ranges mostly from 1,500 to 3,000 tons. They stay in operation from 10 to 20 years.

Iron and wooden vessels (barksy) -- low-decked barges -- are for

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the most part 50 to 85 meters long and 10.7 to 14.9 meters wide. They are used to carry grains and other valuable cargoes down the Volga tributaries. Scows carry petroleum and various dry cargoes. Their region of navigation is below Astrakhan'. Debarkaders are barges of a stationary type. Vessels which have a special use, such as dredges, docks, etc., closely resemble barges in their dimensions.

Barges of the pin-and-nail-bolting type are divided into those which make many trips and those which make only one trip. The majority of ships can make many trips; those that can make only one trip are "belyany," small flat-bottomed unearred vessels which lumber, "podchalki" which couple onto others, flat-decked and "mokshany." Before the war those ships which make one trip worked on all the floatable rivers of the Volga basin. Today almost no floating of vessels takes place in the Volga basin.

Within the bounds of the Nizhnyaya Volga the river fleet serves the following back-waters and repair works:

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Number	Category	Name of Backwater Repair Works	Location	Distance from Mouth, in Meters	Useable Water Area of Backwater in square Meters
	I.	Backwaters and Repair Works on Sudostroyrement			
		Imeni Lenin	Astrakhan'		
		The Third International	Astrakhan'		
		Imeni Stalin (Zolotovo)	Astrakhan'		
		Balakovo	Balakovo		
		Spasskiy Backwater	Spassk		
	II.	Backwaters and Repair Works of VUMT			
		Imeni Uritskiy	Astrakhan'		
		Vladimirovskiye	Vladimirovka		
		Sarepta	Krasnoarmeysk		
		Stalingrad	Stalingrad		
		Zolotov	Saratov		
		Saratov	Saratov		
		Alekseyev	Vol'sk		
		Samara	Samara		
		Kriushin	Ul'yanovsk		

Along with the above mentioned backwaters and repair works on the Volga and its tributaries, there are a large number of winter drydocks which are used under different circumstances (emergencies, light repairs, etc.)

Freight Turnover on the Volga and Its Tributaries

Within the limits of the Nizhneye Povolozh'ye, the following towns and landings are to be found on the Volga: Tetyushi, 48 kilometers below the confluence of the Kama; Ul'yanovsk, 150 kilometers; Samara, with a

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large harbor equipped with railroad facilities, 346 kilometers; Syzran', 155 [illegible] kilometers; Khvalynsk, with an extremely large grain unloading lier and a small harbor, 594 kilometers; Balakovo, 656 kilometers; Vol'sk, the location of large cement plants, 666 kilometers; Marksshtadt, with a landing for grain, 747 kilometers; Engel's, capital of the Volga German Autonomous Republic with railroad connections and a very large landing for grain, 819 kilometers; Saratov, one of the largest landings, (lies not on the mainbody of Volga, but on the branch channel; dredging assures vessels an approach at all times of the navigation period) 822 kilometers; Stalingrad, the largest landing for timber, a center for the lumber industry, and with a tractor works, 1,236 kilometers; Vladimirovka, the largest landing for salt, 1,414 kilometers; Yenotayevsk, 1,501 kilometers; and Astrakhan', the largest petroleum, fish and forest landing, 1,731 kilometers.

The total freight turnover for the Volga and its tributaries within the limits of Rybinsk to Astrakhan' is given in the following figures for the last four years, which show an annual increase: 1928, 8,674,277 tons; 1929, 9,939,160 tons; 1930, 12,147,716 tons. The chief cargoes are petroleum products, grain, mineral construction products, and timber cargoes. The makeup of the freight turnover in percentages is shown in the following figures:

Type of Cargo	1928	1929	1930	1931
Petroleum products				
Bread				
Salt				
Mineral construction materials				
Timber cargoes carried on vessels				
Timber cargoes carried on rafts *				
Other freight				
Total				

* This includes only timber shipped on rafts which are pulled by tugboats. The amount floated by rafts is not included.

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large harbor equipped with railroad facilities, 348 kilometers; Syzran', 155 [?] kilometers; Khvalynsk, with an extremely large grain unloading lier and a small harbor, 594 kilometers; Balakovo, 656 kilometers; Vol'sk, the location of large cement plants, 666 kilometers; Marksshtadt, with a landing for grain, 747 kilometers; Engel's, capital of the Volga German Autonomous Republic with railroad connections and a very large landing for grain, 819 kilometers; Saratov, one of the largest landings, (lies not on the mainbody of Volga, but on the branch channel; dredging assures vessels an approach at all times of the navigation period) 822 kilometers; Stalingrad, the largest landing for timber, a center for the lumber industry, and with a tractor works, 1,236 kilometers; Vladimirovka, the largest landing for salt, 1,414 kilometers; Yenotayevsk, 1,501 kilometers; and Astrakhan', the largest petroleum, fish and forest landing, 1,731 kilometers.

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Bread				
Salt				
Mineral construction materials				
Timber cargoes carried on vessels				
Timber cargoes carried on rafts *				
Other freight				
Total				

* This includes only timber shipped on rafts which are pulled by tugboats. The amount floated by rafts is not included.

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Passenger traffic has also increased annually. The number of passengers amounted to 6,537 persons in 1928; 7,676 in 1929; 11,373 in 1930; 11,702 in 1931.

The composition of freight traffic for 1930 for the Volga on the stretch from Rybinsk to Astrakhan', in terms of incoming and outgoing tonnage, is given in the table below:

Kind of Cargo	Outgoing Tonnage		Incoming Tonnage	
	Up-river	Down-river	Down-river	Up-river
Grain cargoes				
Salt				
Fish				
Animals				
Unprocessed metals				
Cotton				
Cement				
Mineral construction materials				
Anthracite coal				
Petroleum products				
Timber				
Freight				
Total				

The freight traffic for separate sections of the Volga is given in the table below for 1930:

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Section of the Route	Freight Carried in Vessels in Tons			
	Shipped		Received	
	Up-river	Down-river	Up-river	Down-river
Kazan' to Samara				
Samara to Saratov				
Saratov to Stalingrad				
Stalingrad to Astrakhan'				
Total				

The freight traffic on the navigable tributaries of the Volga, located within the limits of Nizhneye Povolozh'ye, is given in the table on the following page.

The work of the VUKT fleet for 1930 is given in the following figures: for one indicated horsepower of tugboat traction -- 133,200 tons per kilometer; for one ton of freight capacity in dry freight barges -- 2,190 tons per kilometer; for one ton of freight capacity in available barges -- 9,246 tons per kilometer.

The increase in freight traffic on the Volga in the past years, together with the growth of industry and economy in the regions bordering it, and the growing importance of the Volga as a main water transport artery in the Soviet Union, brings, in turn, the question of improving navigation along the Volga by increasing and overhauling the fleet and by making the channel adequately deep. The solution of this transport problem may be found in connection with measures for the construction of a powerful power base in Nizhneye Povolzh'ye, the irrigation of arid land on the left-bank, and is elucidated below in the section on complex water-economy measures.

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Name of Tributary	Total Freight Tonnage in tons		Grain Products in tons		Timber in tons		Fish in tons		Petroleum Products in tons		Mineral Construction Material in tons		Salt in tons		Other Freight in tons	
	Shipped	Received	Shipped	Received	Shipped	Received	Shipped	Received	Shipped	Received	Shipped	Received	Shipped	Received	Shipped	Received
Mayna																
Usa																
Sok																
Samara																
Mocha																
Bol'shoy Irgiz																
Akhtuba Branch																
Buzan Branch																
Total																

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2. HYDROELECTRIC RESOURCES AND THEIR UTILIZATION

The basic and almost sole source of hydroelectric energy in the region is represented by the Volga River. The importance of Volga's tributaries in the overall hydroelectric capacity of this region is negligible, in view of the poor development of the river network. Given below is appropriate information concerning the total power capacity of rivers in the region based upon the data of the Academy of Sciences Commission on the Study of Natural Productive Resources of the USSR (KEPS), data of V. V. Gavrilov [1070a] and partially upon the data of A. A. Trufanov [0116a]. Discrepancies between these sets of data, resulting from an inadequate knowledge of the river region and different methods of computations, forces us to regard them only as estimates.

Name of River	Length of River in Kilometers	Gross Power in 1000 Kilowatts: KEPS DATA: Mean Annual Average	KEPS DATA: Minimum Annual	GAVRILOV'S DATA: Mean Annual Average	GAVRILOV'S DATA: Minimum Annual	TRUFANOV'S DATA: Mean Annual	TRUFANOV'S DATA: Minimum
Volga (from Kama's confluence)							
Kostroma							
Bol'shoy Cheremshan							
Malyy Cheremshan							
Usa							
Sok							
Samara							
Tok							
Kinel'							
Mocha							
Syzran							
Bol'shoy Irgiz							
Kamelik							

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		Gross Power in 1000 Kilowatts					
		KEPS DATA		GAVRILOV'S DATA		TROFIMOV'S DATA	
Name of River	Length of River in Kilometers	Mean Annual	Minimum Average	Mean Semi-Annual	Minimum Average	Mean Annual	Minimum
Tereshka							
Yaroslav							
Torgun'							
Rounded Off Totals							

Up to the present time, the water energy of the region has been slightly utilized, finding application only in small turbine and wheel-power installations, primarily for flour mills. The only significant installation is the Syzran hydroelectric plant which is designed to serve the city and its industries (in accordance with the 1938 load estimates) and was built in 1929 at the bend of the river Syzran near the city.

A reinforced concrete dam is more than 200 meters long and 17 meters high, and was constructed on a foundation of partially crushed limestone. Water is delivered to the station by means of an open channel running across the river bend. The station is equipped with horizontal type prime-movers with 3 open internal regulation turbines. The power capacity of each turbine, for a water head of 12.8 meters and 300 revolutions per minute, is equal to 1,140 horsepower, making the total capacity of the station 3,400 horsepower. Generator capacity is based on supplying the calculated peak winter load demand of 1938 (2,050 kilowatts); there are installed three 850 kilowatt generators. The increased turbine capacity as against generator capacity is explainable by the necessity of having increased turbine capacity during high water periods on the Volga.

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POWER KILOWATTS

Maximum load demand is satisfied by employing:

3 Turbines	3 Turbines and an Auxiliary Plant	2 Turbines	3 Turbines and Added Thermal Prime Movers

(1) Capacity of the station with 3 turbines and a net head of 12.8 meters.

(2) Maximum daily station load in Kilowatts.

(3) Maximum station capacity with 3 turbines and variable head.

(4) Average daily station load in Kilowatts.

Figure 100. Mean diurnal and maximum power load demand in 1938, and the average annual power output of the Syzran hydroelectric.

The water reservoir formed by the dam has an 0.5 to 4.5 meters high overflow spillway and can furnish from 4 to 27 millions of cubic meters of water, which are used to satisfy the increased demand for power in wintertime.

There is a sharp drop in the normal water head of 12.8 meters during the months of September through March, due to the lowered level of the regulating water reservoir, and also from the second half of May through the first half of June, due to the swelling of the Volga. Duration of the decreases in pressure during the period of Volga highwater are as follows: 20 days for 7.85 meters to 8.5 meters; 9 days for 8.5-9.00 meters and 7 days for 9-9.7 meters.

Demand for energy (1938 estimate) in the winter months and during Volga highwater is not fully met by the turbines (in view of their inadequate water-passing capacity and lowered efficiency), and this shortage is taken care of by an auxiliary thermal power plant installation of 3 generators, 220 kilowatts each, one of which is held in reserve. Sat-

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isfaction power demand is shown in graph of Fig 10).

No	River	Location of Hydroelectric Stations	Number and Type of Hydroelectric Stations: Wheel	Turbine	Water Head in Meters (within Limits)	Power in Horsepower (within Limits)	Total Horsepower of River Installations: Per Unit	Total
1.	Annual:							
2	Bol'shaya Kinel'	7 kilometers from Plant Kinel						
3	Bol'shaya Kinel'	6 kilometers from Plant Turkenovka						
4	Bol'shaya Kinel'	6 kilometers from Plant Tolkay						
5	Bol'shaya Kinel'							
6	Malaya Kinel'							
7	Kondurcha	15 kilometers from Plant Chalma						
8	Kondurcha							
9	Samara	13 kilometers from Kamalyeyvka Plant						
10	Samara	6 kilometers from Pogromnaya Plant						
11	Samara	10 kilometers from Sorochinskaya Plant						
12	Samara	1.5 kilometers from Sorochinskaya Plant						
13	Samara	12 kilometers from Buzuluk Plant						
14	Samara							
15	Savrushka							
16	Sarbay							
17	Sok							
18	Tolkay							

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Note Symbol indicates that besides hydroelectric-installations there is a diesel engine, the output of which is included in the total power of the installation.

Data on small hydroelectric installations (according to the Central Volga Regional Administration YeGES) is shown in the table on page 561. Power of the turbine installations was determined by the formula N 10 QH (horsepower) and those of wheel installations by formula N 6 QH (horsepower) where Q is water flow in meters per second and H is the is the water head in meters.

Data given in the table is for the years 1926-1928.

Rivers of the northern part of the Nizhneye Povolozh'ye region which are within the administrative boundaries of Tatar ASSR also have a considerable number of water mill installations, built before the war. The spacing of these installations on the majority of rivers is such that the upstream mills are located at the end of the rise caused by the next downstream mill, i.e, 10-15 kilometers apart. The water heads at the mills are between 2 to 3.5 meters.

Out of 770 water mills of the Tatar Republic which are located on small rivers, 89 are within the boundaries of the Nizhneye Povdzh'ye region. Their distribution according to rivers and brief descriptive characteristics is given in the following table (data of 1924):

No	Name of River	Number of Water Mills	Number of Wheels Per Installation	Wheel Diameter in Meters
1	Bol'shoy Cheremshan			
2	Malyy Cheremshan			
3	Bol'shaya and Malaya Sul'cha			
4	Utka			
5	Bezdna			
6	Akhmat			

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No	Name of River	Number of Water Mills	Number of Wheels Per Installation	Wheel Diameter in Meters
7	Murasa			
8	Murasinka			
9	Shcherbenka			
10	Seletun'ka			
11	Kuteminka			
12	Kamenka			
13	Atasya			
14	Sikhterma			
15	Rodyan			
16	Karasinka			
17	At Springs			
	Total:			

Hydrological behavior of these rivers, such as decreases in level from 0.2 to 1 meter per kilometer, their flow in narrow deep river beds, and their high banks sometimes more than 2 meters above mean water level, permit the harnessing of their energy for local needs, by means of earthen water dams with hydroelectric installations having a capacity of 75 to 300 horsepower; some of the dams have sluices to pass floating timber.

No data on small installations in the Saratov and Stalingrad areas was available at the time of compiling of this manual, however, topographic conditions lead us to assume an even more inadequate development of hydroelectric power in these regions.

The water power of the Volga itself in the Nizhneye Povolzh'ye region has not as yet been utilized. The problem of Volga utilization which is coupled with the construction of a dam at Kamyshin and a dam to straighten the Samara bend is of a more complex nature embracing problems of irrigation, transportation and hydroelectric power, and is more fully discussed in the chapter on complex utilization.

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3. WATER SUPPLY

(a) Water supply of cities and industrial installations.

General Information

The problem of communal and industrial water supply is of paramount importance for the cities of the Nizhneye Povolzh'ye region. Within the boundaries of their inhabitable zones there are at present concentrated very large industrial installations. Simultaneously with the growth of industrial power and population, these cities presented such a large water demand for drinking and technical purposes, that it could not be satisfied by the then existing communal facilities. Only 14 cities were served by operating central water supply systems. Despite the proximity of the majority of these cities to large surface water-reservoirs (6 on the Volga and 5 on its big tributaries) the water supply of these cities is not entirely satisfactory in regard to location of the water supply, as well as in regard to the utilization of the capacity of water supply, lac of water sources, quality of water, and scope of service.

All of these water works except those in the cities of Engel's, Pugachev and Kolista were built either during the last century or in the first decade of the 20th century. Therefore most of these city water-works underwent radical reconstruction in recent years. Besides greater utilization of Volga proper, as a source with large reserve of water of satisfactory quality, guarded zones were established, better purification plants were constructed, and in some places (Stalingrad, Saratov, Vol'sk, Balitser) concrete measures were taken to utilize fully contiguous high quality spring water sources in order to improve the water supply for drinking and industrial use.

The most characteristic technical data relative to the water supply of the cities of Nizhneye Povolzh'ye region is given in the following table. This data, compiled between 1927 to 1932, deals with the sources and methods

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Table of the Basic Data of Urban Communal Water Supply System.

No.	City	First Year of Operation	Source of Water Supply	Methods of Water Purification	Pumps		Consumption		Distribution Network		Cost per cubic meter (in kopeks)	
					Horse-power	Output in cubic meters per hour	Estimated, in cubic meters per day	Actual (average) in cubic meters per day	Length in kilometers	Ratio to street length in percent	Cost of operation	Rate
1	Samara		Volga	Sedimentation, filtration, coagulation and chlorination								
2	Saratov		Volga	" "								
3	Kamyshin		Volga	Sedimentation, filtration								
4	Stalingrad		Volga	Sedimentation, filtration, coagulation and chlorination								

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5	Astrakhan		Volga	" "								
6	Ulyanovsk		Svlyaga	" "								
7	Busuluk		Samara	Not purified								
8	Pugachev		Bol'shoy Irgiz	Sedimentation, filtration, coagulation chlorination								
9	Syzran'		Spring water	Sedimentation	Self-	flowing						
10	Kuybyshev		Spring water	Not purified	Self-	flowing				No data		
11	Volsk		Spring water	Not purified								
12	Buguruslan		Artesian wells	Not purified								
13	Engel's	Under construction	Volga	Sedimentation, filtration, coagulation								

Notes: (1) Data applies to central city water works.

(2) Power of pumps is primarily for pump stations of first pumping stage.

(3) Network operation and costs are based on 1932 data.

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of water supply of the respective cities. The order in which the cities are given is as follows: (1) Cities with central water supply from Volga, (2) Cities with central water supply from Volga tributaries, (3) Cities using springs for their central water supply systems, (4) Cities without a central water supply system. The city of Yelista, which is the administrative center of the Kalmyk Autonomous Oblast serves to describe the water supply of the entire region.

Samara

The city of Samara has a new and old water supply system which are interconnected. The old water works, first put in operation in 1887, draws its water from two artesian wells on the banks of the Volga, 2 kilometers from the city. Eighty meters from these wells there is a pumping station, with two pumping stages. The first stage employs two centrifugal pumps, having a combined capacity of 560 cubic meters per hour, and one axial pump of 190 cubic meters per hour capacity; the second stage employs 2 centrifugal pumps having the combine capacity of 455 cubic meters per hour and 3 axial pumps of 400 cubic meters per hour capacity. The total estimated daily delivery of water is 10,000 cubic meters with average well output of 440 cubic meters per hour. This water supply is operating at full capacity.

Construction of the new water works began in 1927/28. The first section has been in operation since 1931, while the second section is not yet completed. The source of water supply is the Volga. From the water reservoir, which is located upstream beyond the city limits, there run two 600-millimeter gravity-flowing conduits which deliver water to the collecting reservoir, whence the first pumping stage pumps it into sedimentation tanks, then into American filters, and from there into the reserve reservoirs. From the reserve reservoirs water is delivered to distribution reservoirs located at the outskirts of the city and is then

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delivered to the city water supply network. The new waterworks is established as being capable of delivering 14,000 cubic meters daily for the first section, 16,000 cubic meters for the second, and 15,000 cubic meters for the third. By the end of 1932, the average daily output was 24,000 cubic meters, which, however, was inadequate for supplying the entire demand for water.

Consumers: Population of Samara (about 225,000 persons), of which 65 percent are served, and communal and industrial establishments. Present day per capita daily water consumption taking into account industrial consumption is 36 liters, and 31 liters, without taking into account industrial needs.

Development in Samara and contiguous areas of large scale industries in the nearest future will require the establishing of a large scale water supply system. The estimated annual water demand of the Samara industrial hub is as follows:

Consumers	Annual Consumption (In Thousands of Cubic Meters)
Population	
Industries	
Other consumption	
Total:	

Completion of the third section of the new water supply system will result in daily water consumption not in excess of 55,000 cubic meters. Drainage was effected into the Samara River without purification. At present the sewer network composition is as follows: Its length is 46.6 kilometers with 718 household sewer connections; daily drainage is 8,700 cubic meters, 18 percent of which are industrial drainage. The system is divided and incomplete and is designed to serve a population of 350,000 persons with a daily water consumption of 22,500 cubic meters. At present

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drainage is into Volga with mechanical purification by means of manual screens. The daily per capita consumption is 36.7 liters. Its main defects are: sewers are built only in the center of town, with the consequent limited radius of population and industrial service, even though it has a large estimated capacity; lack of efficient water purification. Immediate development prospects are: laying of additional sewers to cover 4.5 kilometers; complete sewerage disposal at factories; construction of new drainage at Volga and bar by means of wooden donkey pumps; construction of new rainwater reservoirs and snow melting pits; introduction of new methods for mechanical purification.

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City of Stalingrad

The sources of water supply for Stalingrad and all the enterprises and communities of the so-called greater Stalingrad (from the village of Gynak to the town of Krasnoarmeysk inclusive, that is a territory along the Volga, 45-50 kilometers in length and about 6 kilometers in width), are the Volga with its tributaries and branches, springs and wells, the latter being few in number and 10-15 meters deep, with brackish water and low yield -- these are of minor importance. Greater Stalingrad is divided into five large districts or towns, (counting down the course of the Volga) -- the town of Metallurgorod (metal workers), the town of Tsentrogorod (Old Stalingrad), the town of Leninskiy (Woodmen), the town of Krasnoye (Chemists) and the town of Vodnikov (Water transport and ship workers). At the beginning of the reconstruction period in the USSR, Stalingrad had up to a score of water supply systems, most of which are still in operation.

The water supply system of Tsentrogorod was put into operation in 1930. The water intake from the Volga is located opposite the center of the town, 30 meters from the shore. The intake main consists of pipes 300 meters [illegible] in diameter. The first stage pumping station with a reinforced concrete sump has an output of about 1,110 cubic meters per hour. The water is fed into 3 horizontal, brick settling tanks with a total capacity of 2,336 cubic meters. The water then passes through 9 American-type filters, the total output of which is 15,000 cubic meters per day. After that it goes into a 1,230 cubic meter capacity pure-water reservoir, which it leaves by gravity flow to go to the second stage pumping station. This station is equipped with pumps delivering up to 1,320 cubic meters per hour and feeds the water into the distributing system. The latter consists of several pressure tanks located from 87 to 130 meters above the

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Volga water level, and has a total capacity exceeding 5,000 cubic meters. The distributing system consists of iron and cast-iron pipes 350 to 50 millimeters in diameter, and is 67.5 kilometers long. In 1931, its output was 3,867,000 cubic meters. In 1932, the output was increased as a result of partial remodelling (installation of a new main, adding a new section, 25 kilometers long, to the distributing system, construction of new regulating reservoirs and a relay pumping station, etc.). The consumers include: a population of 358,000 communal and industrial enterprises. The basic deficiency remains the inadequate capacity of the water supply system. The average daily water consumption is 65 liters per capita including municipal and industrial needs. Domestic and potable uses require only 11.5 liters. In 1931, full pumping capacity of the system did not exceed 15,000 cubic meters per day, while the estimated requirements of the city, including the Tractor Plant imeni Dzerzhinskiy and its workers' were 1,500 cubic meters per day. The Volga water at the intake is polluted by sewage discharged into the tributaries, branches, as well as into the main stream of the river. There have been cases of obstruction of the intake suction pipes by ground ice during the autumn ice flow, interfering for one or two days with the operation of the pumps. Coagulation of the water is intermissive. Chlorination is effected before filtration and is inadequate because of insufficient use of chlorine.

Metallogorod consists primarily of the three largest industrial enterprises of Stalingrad: the Tractor Plant imeni Dzerzhinskiy, the Barrikady Plant imeni Il'ich, and the Krasny Oktyabr' Plant imeni Rykov, with their workers' settlements. The population of Metallogorod is about 140,000. The tractor plant during its construction, begun in 1927, had its own water supply system. Its water intake is now abandoned, plant and settlement being connected to the central system. Daily consumption is 6,000 cubic meters.

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The Barrikady Plant has its own water supply system, built about 1916, which draws water from Denezhnaya Volozhka. Its daily output is 5,300 cubic meters; 2,500 cubic meters of which are for drinking purposes. Until 1927, the water was not purified. Since 1928 the water has been subjected to sedimentation, coagulation and chlorination. A protected zone, 800-1,000 meters wide, has been established beginning 100 meters downstream of the water intake and extending for 3 kilometers. It should be mentioned that the water intake clogs up with sand to such a degree that it has raised the problem of discontinuing its use. Daily requirements of the plant and settlement were estimated in 1931 as being 10,000 cubic meters, that is the deficit is equal to the daily output capacity of the system.

The water intake of the Krasnyy Oktyabr' Plant draws water from the Volga 6 kilometers above that of Tsentrogorod. The daily output capacity of the system is 17,400 cubic meters for industrial and up to 2,400 cubic meters for drinking purposes. At the present time, drinking water is drawn from the city water supply. Even in 1931, daily requirements of the plant were 23,000 cubic meters. During the peak consumption hours of the day, part of the settlement located at higher elevation has no water due to lack of pressure.

Development of the water supply for Metallogorod is going on parallel to the construction of a single water supply system for all of Greater Stalingrad.

The town of Lesnikov has a population of about 3,500. There are several water supply systems, small ones for fire fighting in lumber yards located below Yel'shanka, and larger ones, such as the water supply system of the Elektroles. Its water is heavily polluted. The water supply system of the Volga-Kaspiy-Les Sawmill is being built by Vodokanalstroy. Noteworthy is its pumping sump, of a tower type, provided with ice-shields and designed to deliver 2,000 cubic meters per hour. The iron suction

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pipes, which are 450 millimeters in diameter, were laid on the Volga river bed. Construction is conducted under adverse conditions due to abrupt changes in the water level, which made it necessary to install the water intake at a place in the river with considerable depth. In the same area are located the water supply systems of the South-Eastern Railroad and the Petroleum Syndicate.

The town of Khimkov is supplied with water mainly from the Stalingres Power Plant. The supply system was built in 1930 and services in addition to the power plant, the Red Army Settlement, the Chemical Combine, and the Fat Combine, with a total population of about 20,000. The maximum daily output of the first half stage is about 77,000 cubic meters; 4,000 cubic meters for drinking and 37,000 cubic meters for industrial use of the Stalingres Power Plant.

From the water intake, similar to a caisson with intake windows, the water flows by gravity to the sump of the first lift pumping station, into which extend the suction pipes. The pump house is built in the shape of a bridge pier and is equipped with 3 pumps having an output of 6,480 cubic meters per hour. From the pumping plant the water is supplied for industrial as well as for drinking use. The water intended for the latter purpose is pumped to a purification plant provided with vertical settling tanks and Jewell filters having an output of 360 cubic meters per hour. Water for industrial uses is subjected only to sedimentation, provisions being made for coagulation during the spring period. Before entering the settling tanks the water passes through a mixing chamber where it remains for a period of 25 minutes. The second lift pumping plant comprises 3 groups of pumps; for industrial water, for drinking water and for water for fire fighting use. Its total output is about 1,370 cubic meters per hour. At a distance of 1,000 meters from the Stalingres Power Plant is located a pressure tank, buried in the ground and having a

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capacity of 700 cubic meters. The distributing system consists of a cast-iron main, 500 millimeters in diameter, and 3 kilometers long, and distributing pipes (cast-iron) having a length of 4.91 kilometers.

The spring-fed water supply systems of Stalingrad include that of Yel'shanka which supplies the Settlement Inemi Yermana with a protected area 1 kilometer long and 150-500 meters wide, which encloses the zone of water-bearing sands feeding the springs.

Another group of spring-fed water supply systems is located in the region of the town of Vodnikov.

(a) The Krasnoarmeysk water supply system was built in 1940. It is fed by two groups of springs, one in the town itself and another 4 kilometers away. The system is operated by gravity. It consists of iron, cast-iron, and asphalt-coated cardboard pipes, having a diameter of 30-100 millimeters. The length of the 2 mains is 4,665 meters, that of the distributing system 1,210 meters. The daily water supply consumption is 40 liters per capita. The flow of the springs is about 500 cubic meters per day, the daily requirements during the summer months are 1,550 cubic meters. The flow of the springs undergoes drastic fluctuations: In some instances 15 minutes were required to draw one bucketful of water.

(b) The Sudoverf water supply system built in 1930-31. The source is the Zhenbruk springs with a flow of 125 cubic meters per day, provided with 8 cappings from which the water passes to a sand filter and there into 2 collecting reservoirs having a total capacity of 192 cubic meters. From these, the water is supplied by means of 2 mains to the district of stone dwellings and to the Sudoverf area. The system consists of cast-iron pipes 75-250 millimeters in diameter and has a length of 6.5 kilometers. The yield of the springs is inadequate, the daily requirements of the stone dwelling district are around 175 cubic meters, while those of the Sudoverf area are 60 cubic meters.

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The water supply system of the settlement of Staraya Bekatovka is gravity operated and was built in 1923. The flow of the springs is approximately 100 cubic meters per 24 hours. The system consists of pipes 75-100 millimeters in diameter and 3,775 meters long. The output of the system in 1932 was about 220 cubic meters per day; the daily water consumption, 12 liters per capita.

At the Otrada settlement the flow of the springs is 250 cubic meters per 24 hours. A system of pipes 50-100 millimeters in diameter and 2.5 kilometers long include 2 public fountains. Average daily water consumption is 24 liters per capita. At present the daily requirements of both settlements are estimated at 750 cubic meters.

The population of Greater Stalingrad is expected to reach 750,000 in the next few years. Drinking water requirements are estimated at 110,000 cubic meters per day, and 250,000 cubic meters for industrial needs. The new unified water supply system was begun in 1927. The source is the Volga river at the village of Rynok above Sukhaya Mechetka having. The water is to flow by gravity from the intake to the first lift pumping ump and then pass to the purification plant south of the tractor plant at an elevation of 70 meters above the river level. The water for industrial use is to go to the water tower at the Barrikady Plant while the purified water will be pumped from the second lift pumping station to reservoirs located at the airfield and the reservoir near the students barracks beyond Mamai Hill. The third lift pumping plant distributes the water from the airfield reservoirs into all districts of Tsentrogorod. The water supply of the southern district of Stalingrad depends primarily upon the water supply system of the Stalingres Power Plant.

Inasmuch as the unified water supply system is not yet completed, there has been contemplated an expansion of the existing water supply systems to make up water deficit by such appropriate measures as installation of 2 new pumps at the pumping station of the Barrikady Plant, and

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provision of a new pressure main 1.5 kilometers in length, increasing the capacity of the city water supply system by installing an additional electric pump having a delivery of 500 cubic meters per hour; reconversion of the idle, English-type filters into American-type filters, and full utilization of the capacity of the water-tower of the South-Eastern Railroad to meet the railroad's needs. In order to lessen the load on the city supply system, its outlying portions are to be consolidated into one circular network. Temporary use is to be made of the daily surplus of 37,000 cubic meters of water from the Stalingrad Power Plant to meet the requirements of the Chemical Combine, the Fats Combine, the Yerman Settlement and Krasnoarmeysk, by installing settling tanks, second lift pumps and laying the necessary conduits. A separate water supply system is to be installed for the industrial needs of the southern district. A separate supply system is to be constructed providing drinking water and water for industrial use for the Sadovaya district. These measures have been already realized in part, making full utilization of ground water resources for use by nearby communities.

In Tsentrogorod, a sewerage system went into operation in 1917. The system is separatory, designed to discharge 15,000 cubic meters per 24 hours. It includes the area from the 9th of January Square to the Tsaritsa River and from the Volga to the railway. The sewage flows by gravity into the main collector, which is 500 millimeters in diameter, thence over gratings into receiver tanks of the pumping station equipped with 3 pumps having a total capacity of 25 liters per second. From there the water flows through a pressure main, over 2.3 kilometers long, and then passes through double sedimentation tanks to irrigate fields covering an area of 27 hectares. A separate pumping station pumps the sewage water from the Red Barracks district to the same area. The sewage water is discharged into the Volga by way of the Tsaritsa River.

The system consists of circular tile pipes with a total length of

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56 kilometers. The actual volume discharged per day amounts to 2,200 cubic meters (15 percent from water supply system), 70 percent of which is industrial waste. It is used by about 13 percent of the population and by a number of plants and installations. The average daily rate per capita is of about 15 liters, exclusive of industrial waste. One of the deficiencies of the sewerage is its inadequate effective capacity in comparison with actual needs. The Tsaritsa River is highly polluted especially in midsummer. The waste from numerous dwellings along the shore, and from plants, factories and other enterprises (about 3,500 cubic meters daily) is discharged into it.

All the waste water from Metallo(gorod, as well as from a number of industrial installations, is discharged into the Volga, directly or by way of its branches, tributaries and adjoining ravines. Stoppage of sewers occurs frequently. The pumping station units are worn out; their delivery barely reaches 60 percent of the rated capacity.

The second Stalingrad City Conference of the Communist Party in 1931 squarely faced the acute problem of sewage disposal. In consequence, outlined the following remedial measures: (a) Within the next few years, all hospitals, schools, bath houses and laundries located within the area of the existing sewers are to be connected to the city sewerage system. (b) Direct discharge of waste water from the Tsaritsa district into the river is to be discontinued, and, in lieu thereof, a pumping station is to be built on the shore of the Tsaritsa River. (c) Collector mains are to be extended into the more elevated areas of the outlying districts and disposal plants are to be built there. (d) Discharge of waste water from the leather factory into the Volga is to be discontinued and a pumping plant is to be provided for conveying this waste to the irrigation fields. (e) The number of sanitation brigades and sanitation yards is to be increased. The Special Project Construction Commission (Spetsproyektstroy) has prepared plans for a sewerage reconstruction program which allows irrigation of fields only beyond the city limits. In 1932, work was to begin

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on the construction of a pressure main leading to the irrigated fields, as well as on the installation of a new relay pumping station, and a pumping station, laying a collector main across the estuary of the Tsaritsa River and, other projects outlined by the Communist Party Conference.

According to figures of NKKh, in the third quarter of 1932, the sewer system in Tsentrogorod had reached a length of 60 kilometers, while the number of houses utilizing it had increased to 400, with the daily discharge being of 2,247 cubic meters.

In Metallogorod, the Tractor Plant and the Settlement Imeni Dzerzhinskiy (upper and lower) have a separate sewer system not as yet completed. It consists of pipes 100 to 450 millimeters in diameter and is 16 kilometers in length. The purification plant is to include Emsher wells and biofilters. At the present time only the wells are in operation. The waste water is discharged into the Mokraya Mechetka River (a tributary of the Volga). Due to a considerable increase of population, the purification plant has an overload of 50 percent.

The Barrikady Plant and Settlement Imeni Il'ich also have a separate sewer system consisting of 100-300 millimeter pipes extending over a length of 5.25 kilometers. This sewerage is overloaded by excess waste water. The purification installation (settling tanks) is also overloaded.

The Settlement Imeni Rykov and Krasnyy Oktyabr' Plant have no sewers with the exception of a group of mansard houses having a primitive mechanical purification system. Waste water is discharged into a ravine.

The layout and plans of an efficient sewer system for all of Metallogordo have been prepared and are being put into effect by the Special Construction Project Commission (Spetsproyektstroy). During 1932, the system is to be extended to a length of 25 kilometers, while in 1933, a pumping station is to be built for conveying waste water to irrigation

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fields.

Sewers were installed in 1930-1931 in the settlement Lmond Yerman. The waste water, without being purified, passes into the industrial waste collector of the Stalingrad Power Plant, and from there into the Volga. The area of the Chemical Combine is also partially provided with sewer system connected to that of the Stalingrad Power Plant.

Voditskov has no sewer system. The 1931 Communist Party Conference instructed the city soviet to plan a sewer system for the Sudoverf district.

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(b) Rural Water Supply

General Data

The rural water supply is greatly affected by the hydrological conditions of the Nizhneye Povolzh'ye region. Unfortunately in view of the scarcity of data and thefact that information has been obtained at different times and is often even conflicting, there is no possibility of throwing light on the conditions and character of the rural water supply with due fullness. This applies particularly to the area in that section of the Middle-Volga region on which we have, for the most part only fragmentary data, dating to the pre-revolutionary period. There is almost no information, expressed in figures, on the needier sections of the Nizhneye Povolzh'ye region, as well as the territory of the Aral-Caspian lowland. Besides, available later information refers mainly to the period of the beginning of the First 5-Year Plan, while during that time there sprang up about 4,000 new settlements in the former Nizhne-Volga Kray alone, a fact which undoubtedly affected the water supply, particularly when one takes into account the fact that these new and the majority of the old settlements were converted into settlements with an economy of the socialist kind, laying greater claim to the water supply. A general characteristic of the area's water resources is their relative scarcity, and common notions on the normalization of water consumption undergo substantial modification under the conditions of the Lower Volga. Even special investigations of the problems of water supply in the Lower Volga, in determining the yield of a water source, the quality of the water, the degree of water consumption and the technical organization of the economy with regard to the water supply, confine themselves, most often, to such rather

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vague qualifications as: "yield adequate," or "water good," or "becomes polluted," or "dries up," etc. Finally, the peculiarity of the natural and economic conditions in the lower Volga area has also laid a sharp imprint on the methods and forms of utilization of water sources: for example, one and the same spring, pond, or well can serve for drinking (by people and livestock), for household use, for putting out fires and for irrigation purposes. To establish the importance of such a water source, with respect to water supply presents considerable difficulties.

The Nizhneye Povolzh'ye region may be divided in two parts with regard to the water supply: the right-bank part and the left-bank part, as determined by the course of the Volga. The right-bank section, on the whole, is distinguished by a relative abundance of surface and subsoil fresh water sources, more up-to-date technical organization, and better sanitary conditions. The left-bank section is significantly poorer in water sources suitable for water supply. The water is characterized by great mineralization, the degree of technical water supply measures is less adequate, and the sanitary water supply set-up is primitive.

These sections, in their turn, are divided into various districts shown on the accompanying map under suitable headings. In view of the fact that the initial data on the water supply in the Nizhneye Povolzh'ye region refer to former uyezd boundaries, the determination of regional boundaries has also been based on uyezd divisions. The right-bank section is divided into three regions.

I. A region of relatively adequate water supply, its territory extending to the southern boundary of the former Saratov Uyezd (Syzrano-Saratov region).

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II. A region of limited water supply, which encompasses part of the right-bank districts of the Volga German Autonomous Soviet Socialist Republic and is bounded on the south by theformer Tsaritsyn Uyezd (Kamyshin-Stalingrad region).

III. A region without established water supply. This includes the whole Kalmytskaya Avtonomnaya Oblast (Kalmyk region).

It was quite difficult to separate from Region I the sections belonging to the Don basin; but since the territory of these sections is insignificant by comparison with the territory of the sections belonging to the Volga basin, the combination of their quantitative water-supply constitutes a hardly noticeable portion in the sum of data for the whole region.

The left-bank section also forms three regions.

IV. A region of relatively adequate water supply encompassing the whole northern part of the Nizhnoye Povolzh'ye region, up to the northern boundary of the former Pugachev Uyezd (Samara region).

V. A region of inadequate water supply extending along the left bank of the Volga, including the former Pugachev and Novouzensk Uyezds and the left-bank portion of the Volga German ASSR. (Novouzensk region).

VI. A region without established water supply -- the entire left-bank portion of the Aral-Caspian lowland, including the lands of the former Bukeyev Orda (Urda region).

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Kamyshin-Stalingrad Region

This region encompasses those portions of the former Kamyshin and Tsaritsyn Uyezds which could be regarded as part of the Volga basin. Thus, for Kamyshin Uyezd, information refers to the territories of the former volosts: Antipov, Akhmat, Bankov, Zolotov, Prigorod, and Ust'-Khalalin. They include the right-bank portion of the Volga German ASSR belonging to the Volga basin and the whole western strip of the Uyezd, making up the northern part of the district. In the former Tsaritsyn Uyezd the territories of the following former volosts are included: Malykley, Yerzov, Lipov, Otradin, Peshkovat, Proley, Romanov, and Sarepta, together making up the southern part of the region. The northern part of the region is characterized by a gradual decline of conditions for satisfactory water-supply as one proceeds south to Kamyshin. Noticeable are the greater fluctuations in the yield of sub-soil waters and the disappearance of small rivers and brooks, whose channels turn into dry ravines. Populated places are most often situated along the shore of the Volga and close to the larger of its tributaries. The southern part of the region already bears the marks of a semi-desert, and only the nearness of the Volga made it possible for people to settle along littoral belt.

The degree to which inhabited places are provided with surface water sources is very insignificant. As a rule, water supply utilizes surface water sources in combination with sub-soil sources. The predominating combination of drinking water sources is: springs, wells and their total sum. 69.9 percent of inhabited places and 58.4 percent of the population rely on this combination. For human drinking purposes, 37.7 percent of inhabited places use water from rivers, 7.3 percent from

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streams, 89 percent from springs, and 71.6 percent from wells.

Rivers

Of the inhabited places that were under study situated near rivers (27 [sic] out of 69 villages) 40 are situated near the Volga, and part of these use Volga water exclusively. But utilization of this water source is attended by a number of difficulties. The steepness of the banks at times makes the water inaccessible, since approaches are not arranged in the majority of the villages. Boats are anchored close to inhabited places, thereby polluting the water with refuse. There is an absence of water systems with pumping stations for transporting of water, as a consequence of which a part of the inhabited places not directly situated on the river, but somewhat at a distance, are deprived of the possibility of taking full advantage of the Volga's water. Among the other rivers two types are to be found. One has a constant surface flow, which, however, decreases considerably in the middle of the summer, so that many small rivers turn into brooks with an insignificant current. Such are the Kamyshinka, Tsaritsa, Ilovlya, Olen'ya, Peschanka, Bobrinka and others. All the other Volga tributaries, of the first and higher categories, the Sukhaya Osinovka, Zhivaya Osinovka, Danilovka, Peskovatka, Zolotukha, Kulalinka, Lipovka and many others, are either brooks drying up toward summer, or dying out shallow streams, flowing along the water-collecting depressions of ravines. Therefore the only method of regulating the river water supply is by damming up the flow of water for impounding the latter. But this method is used in only 27.5 percent of inhabited places.

Characterizing in more detail the district's river water supply, on the basis of these inhabited places, it should be said that approximately 93 percent of the inhabited places use rivers which become

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covered with ice; 20 percent, rivers which freeze down to the bottom; and 22 percent, rivers which dry up in summer. Of the rivers with dams, 47 percent have earthen dams; 42 percent, dams of earth and manure; and the remaining ones of wood and earth. Only about 50 percent of the inhabited places using rivers for water supply have good water. With respect to the others the water is either muddy, or salty, or has an unpleasant odor. Besides, the quality of the water in 42 percent of the inhabited places becomes worse in the summer. The water of almost 70 percent of the inhabited places is polluted by discharges, 33 percent by livestock watering, and in 33 percent by clothes-washing. Finally, it may be pointed out that of the inhabited places using river water, 38 percent use it for drinking; 71 percent, for watering livestock; 52 percent, for household needs; and 5% percent, for the purpose of putting out fires.

In addition, special attention must be called in the region to the appearance of salt in the water, owing to lixiviation of salt-marsh spots, particularly noticeable south of Kamyshin.

Lakes

Lakes play almost no part in the region's water supply. In the northern part, 4 lakes were inspected near 3 inhabited places; they are all situated near, but outside the inhabited places, have surface areas from 5,000 up to 13,500 square meters and a depth from 1 to 3.5 meters. Although the water in them is good, still their being at a distance from the inhabited places (up to 1 kilometer) limits utilization of their water to use by livestock and to certain household uses, particularly watering kitchen gardens.

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Ponds

Ponds are the second type of surface water source in the region and they occupy an importance place for household uses and for putting out fires, if not for drinking purposes. However, the insufficiency of the rivers' power under the poor technical damming-up arrangement, and unsanitary conditions of the impounded waters significantly reduce the role of ponds in the region's water supply.

The pond water supply in the district's inhabited places may be characterised by the following data. Of 41 inhabited places inspected, 17 have one pond each; 10, two ponds each; the remaining ones, three or more ponds. There are flowing ponds in 17 villages, non-flowing in 27 villages. Moreover, only 6 villages have excavated ponds. In the others the ponds are formed by damming rivers, gullies and springs. Ponds have a depth of up to 0.7 meters in 14 villages, up to 1.5 meters in 15 villages, up to 2 meters in 15 villages and up to 3 meters and more in 12 villages. The ponds freeze in winter for 18 villages and dry up in summer for 14. Good pond water is found in only 6 villages; in the others it is of poor quality. Pond water is used for drinking in only 3 villages; in 27 villages it serves for watering livestock; in 12, household needs; and in 28 for putting out fires. It may be noted that the civil war and, following it, the epidemics and famine which struck the Volga region, brought on a considerable deterioration in pond maintenance. More than 60 percent of the ponds were destroyed in that period. At the present time work is being carried on for the restoration and improvement of the technical set-up of ponds.

Springs

Springs, as sources of water supply, occupy one of the most important places in the district and are thoroughly utilized. The following

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data may serve to characterize the spring water supply. Of 73 inspected villages having spring water supply, in 22 villages the springs are not capped, in 7 there is a stone cap, and in 50 a wooden cap. In 8 villages the springs dry up in summer, in 12 their yield is insufficient. Most of the other villages have an adequate yield of spring water. Moreover, in 64 villages the quality of the water is shown to be good, even though in 3 villages the water is polluted by sewage drainage, in 10 by livestock drinking, and in 40 by meteoric (meteornyye) waters. Spring water is used for drinking in 61 villages, for watering livestock in 47 villages, and for household needs in 52 villages.

Moreover, in addition to the utilization of spring water at the point of outlet, cases are not rare, particularly in the northern part of the construction of elementary water supply systems. Thus, in the northern part, there are water supply systems in the following localities, mainly in the right-bank portion of the Volga German ASSR. Zolotoye (pressure system with mechanical distribution of water and a network 6 kilometers in length); Potapovo (gravity flowing with wooden water main 1.6 kilometers in length); Verkhne-Bannoye (also wooden -- 0.96 kilometers in length); Nizhne-Bannoe, Melovoe and other places. In the southern part, water systems have been built in Karavainka (iron water pipes 830 meters in length), Beketovka, Otrada (these came under the description of urban water supply), and in a number of other places. The altitude of springs in 20 percent of the villages in the northern section and 39 percent in the southern is wholly favorable to the construction or development in them of water systems, and such work is being carried on at the present time (Rynok, Gorki Belyye, Melovoye).

Wells

Wells have the most important share in the district's rural water

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supply. Wells are sunk to the following depths in the northern part: minimum depth from 3 to 6.5 meters; average, from 6.5 to 13 meters in 50 percent of the villages; and the deepest, from 13 to 25 meters. In the southern part minimum depths are from 2 to 3.5 meters; average, from 3.5 to 6 meters in 41 percent of the villages; and the deepest from 6 to 12 (and rarely up to 20) meters. In this way there is a predominance of shallow sub-surface water with all its shortcomings. Moreover, the water distinctly appears to be getting brackish in almost 35 percent of the wells, due to which the percentage of their utilization for drinking purposes is significantly lessened.

Of 2,861 wells in 85 villages inspected, 1,[illegible] wells are situated in yards, 475 on squares and streets, 479 in vegetable gardens and fruit gardens, and 64 outside the villages. Further, of 796 wells inspected with regard to their organization, 0.5 percent have no bracing, 2 percent have a stone bracing, 0.13 percent have a woven reed bracing, and the remaining ones have a wooden framework bracing. Satisfactory bracing conditions are found in 60 percent of the wells. 29 percent of the wells have covers; 16 percent, ramps; and 1.6 percent, raised platforms. Good quality water is found in 42.5 percent of the wells; salty and brackish water in 34.9 percent; muddy in 10.6 percent; hard in 9.0 percent; with an odor in 24.5 percent; and with an unpleasant taste in 3.1 percent of the wells. Information on the utilization of well water is available only for the southern half of the district, where 63.6 percent of the wells inspected are used for drinking, 76.1 percent for watering livestock, 67.5 percent for household needs, and 81.8 percent for fire fighting purposes.

In general, water-supply in the district must be recognized as inadequately providing for water requirements. The principal reasons

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for this are the not quite favorable (and, in the southern section, unfavorable) natural conditions. Due to these conditions and the imperfection of technical arrangements, the villages' water supply from surface water sources is quite limited. The relative abundance of subsoil waters is attended, however, by a gradual falling of the water table, which causes a partial exhaustion and, not rarely, a decrease in their yield. The soil's mineralization has a negative influence on the quality of the water, making the water unfit for drinking, and partly unfit for household needs. A favorable circumstance is the presence of spring waters, the yield and quality of which, with proper care of the sources, might to a considerable extent make up the water supply deficit. However, technical arrangements for utilizing sub-soil waters are, in an overwhelming number of cases, primitive. Wells are sunk the first water layers, are badly built, and are subject to the intensified action of internal negative factors, both natural and caused by local living conditions. Springs are capped in only 60 percent of cases, and their capping is technically imperfect, as a consequence of which there follows a silting-up of the outlets and a worsening in the quality of the waters. By comparison with the possibilities, insufficient advantage is taken of the topography of the locality for the centralized water supply systems of the simplest kind.

The sanitary water-supply conditions are poor, because of the technical imperfection of the facilities for utilizing water sources and because of the population's non-observance of the safety rules pertaining to the purity of the water-supply sources and their surrounding territories.

Measures for the development and improvement of the water supply for the district have been taken since the beginning of the reconstruction period. Thus, in the northern part, during 1924-25, dozens of ponds,

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wells and capped springs were restored or newly built. With reconstruction of agriculture possibilities are created for combating the above mentioned water-supply shortcomings, by regulating the surface flow with improved-type dams, by reforestation of the territory, by building wells on stable water bodies, and furnishing them with covers, ramps, public buckets, and raised platforms, by increased use of spring waters, through capping outlets with first class methods and increasing the number of water-supply works with types which have been justified by several years' experience

or this way

either this way

Figure 101. Kinds of Kalmyk Khuduk type wells.

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Except for fragmentary data on a few settlements of this Rayon, which includes the whole left-bank area of the Volga south of the Yeruslan River and its tributary, the Torgun, the remaining data on the water supply of the region may be obtained only from an analysis of the investigations and surveys made in connection with the Government reclamation projects. The region is sharply divided into two parts: (1) the section of the Volga-Akhtuba flood plain and the Volga delta, including the shore of the Caspian Sea near the southwestern boundaries of the Rayon, and (2) the remainder of the territory, comprising the Aral-Caspian semi-desert.

The former section has extremely abundant supplies of water, which provide for all requirements of agriculture. Only in the Caspian shore area, bordering the steppe, is the supply of water somewhat less. The settlements, especially on the Delta formations of the Volga, use the waters of the numberless outlet channels (yerik) and ditches that criss-cross the country in every direction. Wells are not widely distributed, however, in spite of the abundance of ground water at depths of 0.35 to 2.0 meters, which results from the plentiful and constant supply of surface water.

In the coastal zones of the Volga and the Caspian, there is no longer such an abundance of surface water, and the settlements use the il'mens for their water supply. Various types of simple dams equipped with the simplest kind of sluices to hold the water in the il'men have evolved with local practices.

Conditions are different in the remainder of the Rayon, which has been explored by the Povolozh'ye Expedition for Colonization and Melioration, on the territory of the former Leninsk Uyezd and the Nikolayevsk Uyezd. The flat steppe relief is almost entirely unbroken by river

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valleys and ravines, except for the left-bank tributaries of the Yeruslan and Torgun rivers and the downstream section of the Gor'kaya and the Great and Little Uzen' rivers. The relief is dotted by infrequent limans with their system of almost featureless shallow troughs and ravines which feed immense supplies of water, mostly from the melting snows, into the limans which usually dry out by midsummer. The populated points located in the westerly belt of the region, are supplied for the most part by ground water; only on the floodplain of the Akhtuba do they use the reliable supplies of water (which are only slightly mineralized) from the numerous floodplain lakes, or the freshwater from the sands of the Barkhan dunes, to supplement their own well water. Thus, Chapchachi station draws a constant, year-round supply of water from these lakes; and in the territory explored by the Povolzh'ye Expedition for Colonization and Melioration, ground water was frequently accumulated in the upper levels of the Caspian deposits, in thick layers of loess-type clays and sands of the steppe series, and even higher, in the clay-sand strata of chocolate brown clays with their seams of Khvalinsk series sands. Out of 297 wells and "khudyk" studied here, 183 yielded entirely potable water, while 69 wells yielded water of higher salinity, which, however, could be used for watering cattle and for agricultural purposes, and only in 18.2 percent of the wells was the water highly saline. The depth of the wells ranged from 3.6 to 21 meters. The salinity of water from levels lower than 9.5 meters exceeded the limit for utilizable water.

There are no reliable ground waters above the depth of 200 meters on the steppe section; in depths below 200 meters fresh artesian water is more likely to be present, but it is still impossible to formulate any rule under these circumstances, as ground water collects in drainage pipes at depths of only 6 to 30 meters at some stations on the Saratov-Astrakhan

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railroad (Saykhin and Baskunchak stations). In some places between Shungay and Bogdo stations, a depth of 64 meters yields potable water at the rate of 5 to 20 cubic meters an hour (Bogdo Station). On the other hand, at Djanybek Station, artesian wells to horizons as deep as 125 meters yielded water unsuitable for use. The neighborhood of Lake El'ton is more favorable than other localities of the steppe section, since it has ravines, troughs and other depressions which accumulate water from the melting snow; 70 percent of 195 bored wells here yielded potable water, while the water from 45 percent of 257 dug wells was good.

On the basis of this study, it was determined that, among the economic measures to be taken in the western section of the region, it was necessary to include the construction of 25 dams, 147 shaft wells and 147 bored wells.

The Baskunchakskiy Rayon was separately studied in connection with the water-supply for the Bassol'Trest Enterprises. Observations on the ground waters of the Rayon covering the existing sources and 15 borings from 35 to 67 meters in depth gave the characteristic features of the ground waters in the belt from the Ryazan-Ural'sk railroad to the Volga, with a width of about 40 kilometers and its center at Baskunchak Station. The existence of two water-bearing horizons was established at depths from 15 to 30 meters in the gypsum-bearing sands of the Khvalynsk series, and at depths of about 60 meters in the Khazar sands, under which lie the flat stratum of bluish-gray Bakin clays. In both cases a slope from the steppe section towards the Volga was noted, with a flow in the direction of this slope. It was also observed that in the upper horizon the mineral content of the water increased in the direction of the steppes reaching levels of 1000 milligrams per liter and higher at Kharkhoy Station, Irgali Aul, while fresh water was prevalent in the lower horizon.

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The Verkhniy Baskunchak Station obtains water from the lower horizon by pipes of 150 to 200 millimeter diameter sunk in borings. The rate of flow is 1.5 to 2 liters per second from the first boring and about 3 liters per second in the other, while the average daily requirement is 370 cubic meters, or about 4.3 liters per second. Based on these preliminary studies, the water requirements of the Kaspol'Trest Enterprises were estimated at 246 cubic meters per day. According to the opinion of persons who have studied the region, the estimated reserves of ground water should last for 26 years at this rate of usage.

East of the Ryazan-Ural'sk railroad the steppe takes on a desert character, and data on its water supply have not yet been recorded.

According to the water supply situation, the populated area of the region may be divided into two parts: (1) the administrative Rayons of the Volga delta: Zelenchinskiy, Kamyzyakskiy, Ikryanskiy and Astrakhanskiy, in which the water requirements are met 100 percent, and only in Krasnoyarskiy Rayon is the supply insufficient, meeting only 75 percent of requirements. (2) All the remaining Rayons, in which about 40 percent of water requirements are met, mainly from the excess waters in the western belt of the Volga-Akhtuba flood plain.

The development of the water supply in sections now undersupplied will be served by the Second Five Year Plan development projects for the territories of the eastern section of the region. In addition it is planned to increase the water supply as the solution of irrigation problems proceeds.

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4. IRRIGATION IN THE LOWER POVOLZH'YE

Hydrological Conditions of Agriculture

The immediate proximity of the Lower Volga region to the desert steppes of Central Asia is responsible for its emphatically continental climate. Precipitation is scanty, fluctuating and irregularly distributed, with hot summers, rapid, irregular transition from winter to summer, and an uneven incidence of the scorching sirocco. All these create a condition of intense insolation and sharply reduce the relative humidity of the air. Temperatures vary through a wide range between day and night, precipitation is insufficient, and the soils are often parched by the scorching winds, resulting in their transition from chernozem to desert-chestnut and brown soils of complex type, with extensive distribution of solonetzes and solonchaks. Owing to the lack of cover, especially in the south, the winter winds blow the snow from the plains and divides into the ravines and minor rivers; so that with the rapid onset of spring the thawing of the ground lags behind the thawing of the snow, and the spring waters, unable to penetrate the still frozen ground, are unproductively borne away by the little rivers of the steppe. All these factors call forth the occurrence of drought and crop failure.

The degree of aridity of a region for meliorative purposes is expressed by the value of the coefficient of water balance as given by A. N. Kostyakov's formula: $K = \frac{M}{E}$, where (rho) is the precipitation in millimeters during the period in question, E is the aggregate evaporation in millimeters over the same period, and $M = 1 -$, where (delta) is the coefficient of run-off. The value of the coefficient K is less than 1 for all of the Lower Povolzh'ye, falling to 0.61 for the Saratovskiy Rayon and to 0.24 for the Astrakhanskiy Rayon. According to data furnished

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by the TsSU, a drought has occurred every four years since 1897, with the drought of 1907 lasting for two successive years, so that the number of such years amounted on the average to one-third of the number of favorable summers.

The following table shows the fluctuation inproductivity caused by drought. [Source Materials, 1919]

ZONES OBSERVED		YEARS OF OBSERVATION	Productivity of Wheat in Tsentner per Hectare		
			Maximum	Minimum	Average
PEASANT FARMS	Former Pugachev Uyezd				
	Former Novo-Uzen' Uyezd				
EXPERIMENT STATIONS	Buzuluk				
	Krasno-Kut				

The worst droughts affect the grasses, orchards and vegetable gardens. The cereal crops are lessensitive, and are very widely distributed in the agriculture of the Lower Povolzh'ye, but they too are exposed to the ruinous activity of droughts and siroccos. Thus, since droughts are frequent, intensive work on the irrigation, water-supply, and afforestation of the region is a prerequisite to the establishment of a stable basis for cereal cultivation and the introduction of the valuable technical crops, despite the technical development of agricultural engineering and mechanization.

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The entire region can be divided into a number of zones according to hydrometeorological and agricultural conditions. Thus, the following zones are to be found within the administrative boundaries of the Srednoe Volga Kray:

1. The Northern Belt of the Trans-Volga Forest-Steppe

Moderate temperatures and an adequate rainfall during the summer period, together with a well-developed river system and the presence of black-earth soils, make possible costly cultivation of summer crops, while the cold winter with its unstable snow cover requires the planting of winter-resistant crops.

2. The Southern Belt of the Trans-Volga Forest-Steppe

The growing season is marked by warm and occasionally high temperatures with heavy solar radiation, negligible rainfall, and frequent drought. The winter period is characterized by severe temperature conditions and a slight snow cover. These conditions require the planting of winter- and drought-resistant crops. The topography of the area and the well-developed river system make it possible to irrigate the area properly to combat drought with inexpensive hydrotechnical construction.

3. The Central and Southern Parts of the Left-Shore Steppe

The central and southern parts of the left-shore steppe are characterized by still higher temperatures for the growing season, less rain with abundant solar radiation, high evaporation, a severe winter with little snow, and frequent drought. Drought-resistant crops with a long growing period should be planted here.

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The following zones are to be found in the administrative boundaries of the former Nizhne Volga Kray ("Materialy," 1519):

1. The Tsentral'nyy, Privolzhskiy, and part of the Priozerskiy rayons of Kalmytskaya Oblast and the steppe areas of Krasnoyarskiy, Yenotayevskiy, Kharabalinskiy and Vladimirskiy rayons. This zone is a sandy, arid semi-desert without snow where animal husbandry is developed extensively. Very little irrigation can be obtained by using local runoff collecting in estuaries (liman). However, up to 100,000 hectares of land can be irrigated for truck-gardening and technical crops by using sluices and mechanical irrigation from the steppe marsh lakes. Irrigation from the Volga during high water is also possible. In addition, the feasibility of irrigation in the Priozerskiy Rayon by means of a canal from Yandyk into the heart of the steppes is under study. Water supply is insufficient and is obtained only from wells sunk to the shallow subsurface table. It may be possible to supply part of the zone with water by piping it from the steppe lakes.

2. The Tsentral'nyy and Sarpinskiy rayons of Kalmytskaya Oblast, parts of Krasnoarmeyskiy, Vladimirskiy, Piterskiy, and Novouzenskiy rayons, and the Leninskiy, Srednе-Akhtubinskiy, Chernoyarskiy, Nikolayevskiy, and Pallasovskiy rayons. This is a zone of riverless plains with little snow and solonetz soil where cattle-raising is extensive. The establishment of regular and estuary irrigation using local runoff and creation of sluices for the Torgun' and Yeruslan rivers are necessary and possible. Irrigation is possible by using water from the Volga and, in the trans-Volga, by Ural waters. Water must also be provided by the construction of wells.

3. Parts of the Tsentral'nyy and Sarpinskiy rayons of the Kalmytskaya Oblast, the Zel'manovskiy, Krasnokutskiy, Engel'skiy, Marxental'skiy,

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Fedorovskiy, Dergachevskiy, Yershovskiy, Dukhovitskiy, Pervolyubskiy, Pugachevskiy, Ivantyevskiy, Perkushkinskiy, Dukhovitskiy, and Balakovskiy rayons, and parts of the Stalingradskiy, Kremenskiy, Piterskiy, and Novouzenskiy rayons. This is a zone of chestnut and black-earth soils with a considerable number of rivers which carry a good deal of water in spring, but dry up in summer. Wheat, oats, safflower, and fodder crops are commonly planted here. Irrigation by means of local runoff as well as by Volga waters is necessary and possible. Water supply is provided by ponds and artesian wells. Reforestation is necessary.

4. The region of the right shore north of Kalinovskaya Luka. This is a zone of black-earth soils with a considerable winter rainfall and year-round rivers. Grain, cultivated, and fodder crops for small-scale cattle raising are commonly planted. The runoff of local rivers and many springs could be used for regular natural and mechanical irrigation. A slight volume of ordinary (flood) irrigation is possible. Mechanical irrigation by Volga waters is possible in the strip immediately bordering on the Volga. Water supply is provided by ponds and wells. Erosion around ravines should be counteracted by planting of trees.

5. The Volga-Akhtuba bottom land and the Volga delta, a zone of fruit, truck, vegetable and technical crops. The Volga delta should be surrounded with mechanical water supply for irrigation, reforestation, meadow reclamation in the bottom land, and securing of sands in the steppe areas. Measures for fish conservation, including the creation of junctions for river channels with marsh lakes, are necessary.

Collective farms on a mass basis and the organization of specialized sovkhozes, employing scientific farming and mechanization to the utmost degree create favorable conditions for the irrigation of

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large land masses and the construction and explitation of irrigation systems, which should result in a considerable increase in the number and productive capacity of farm acreages, thus providing reliable production.

The total arable land within the administrative boundaries of the Sredne-Volga Kray (according to material compiled by the Sector of Land Reserves, People's Commissariat of Agriculture USSR, report of 1930-31) is 23,862,000 hectares and is distributed with respect to acreages in the following way (Afremov and Morozov, rkp, 1932).

		Right Shore		Left Shore		Entire Kray	
		Thousands		Thousands		Thousands	
Number	Acreage	of Hectares	Per-cent	of Hectares	Per-cent	of Hectares	Per-cent
1	Farmsteads, orchards and vegetable gardens						
2	Ploughed land						
3	Hay						
4	Common land						
5	Pasture						
6	Trees and shrubs						
7	Swamps and salt pans						
8	Canebrakes						
9	Ravines, sandy areas, areas under water, and other unsuitable lands						

The arable area within the administrative boundaries of the Nizhne-Volga Kray according to zones is characterized by the following table (Materialy, 1519):

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Number	Acreage	Zone I		Zone II		Zone III		Zone IV		Zone V		Entire Kray	
		Thousands of Hectares	Percent	Thousands of Hectares	Percent	Thousands of Hectares	Percent	Thousands of Hectares	Percent	Thousands of Hectares	Percent	Thousands of Hectares	Percent
1	Farmsteads, gardens, and truck gardens												
2	Ploughed reserve												
3	Hay												
4	Pastures												
5	Trees and shrubs												
6	Cane and chekan												
7	Other suitable lands												
8	Total suitable lands												
9	Unsuitable lands												
	Total												

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Including as unsuitable lands requiring reclamation ravines, sandy areas, salt pans, peat bogs, swampy sandy areas, rocky spots, etc., we obtain the following areas of unsuitable lands within the administrative boundaries of the Srednе-Volga Kray -- 604,400 hectares and the Nizhne-Volga Kray -- 2,892,800 hectares, or a total of 3,497,200 hectares. This, however, is not the sum total of land needing reclamation. A considerable part of the land now in use requires hydrotechnical and cultural technical measures to improve its productivity. Work in this field should be concentrated on moisture storage and irrigation, since only water supply can increase the harvest, make it more stable, and free part of the land for more intensive crops and development of animal husbandry.

Development of Irrigation in the Lands Along the Volga

The origin of irrigation measures in Nizhneye Povolzh'ye dates to the first half of the 19th century. Reports of 1846 tell of the establishment of irrigation for orchards and vegetable-gardens by peasants over an area of 650 hectares in 16 villages of the former Saratov Gubernlya. More or less systematic work, however, began only in 1860-1865, with the organization of I. I. Zhilinskiy's expedition. The work of the expedition from 1860 to 1885 consisted of investigations and the construction of weirs and wells for water supply of the Kalmyk steppes and the building of irrigation works in the former Astrakhan' and Samara guberniyas, in the Tinguta, Berezovka, Kocheta, and Valuyki areas, in the Solyanka Ravine and in other small sectors. The expedition became even more active after 1891. New irrigation works were built, while estuary (liman) irrigation was repaired and reconstructed into a regular network with water supplied by both natural and bucket-

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conveyer methods. This measure increased the irrigated area in the old Samara, Saratov, and Astrakhan' guberniyas to 6,000 hectares by 1914. The successful results of irrigation and the frequent repetition of droughts and crop losses in the following years led to a general increase in the irrigated areas of agricultural experiment stations and to the development of irrigation on lands held by peasants' societies and individual owners. Nevertheless, the appropriations approved by the zemstvo for this work were entirely insufficient. No sort of large-scale irrigation work was conducted (especially in the peasants' lands), and many irrigation works fell into decay.

According to the data on irrigation study in the former Novouzensk Uyezd (Second Volga Survey Party of the Division of Land Reclamation, 1914), the Novouzensk zemstvo had constructed, since the beginning of the nineties [sic], estuary (11 km) and regular irrigation over an area of about 13,000 hectares. In addition, the rural societies had several irrigated sections with areas from 10 to 25 hectares; the irrigated land in the district totaled about 30,000 hectares (Prolov, 1459). A study was made in the basins of the Bol'shoy and Malyy Uzen', the Torgun', and the Yeruslan rivers with the following results. In the Bol'shoy Uzen' basin, 600 hectares were under mechanical irrigation with 4 systems, while 7,450 hectares were irrigated by estuary (11 km). In the Malyy Uzen', Torgun', and Yeruslan basins, 1,350 hectares were under mechanical irrigation. Mechanical irrigation was used chiefly for vegetable and grain crops, while grasses and, to a lesser degree, vegetable and grain crops, were planted in areas irrigated by estuary.

The following table gives wheat harvest data in the sections studied from reports covering the years 1905-1914.

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Method of Irrigation	Wheat Harvest in Centners per Hectare			
	Dry Years		Wet Years	
	Average Harvest	Percent Increase	Average Harvest	Percent Increase
Without irrigation				
With liman irrigation				
With regular irrigation				

The use of a region on the right shore of the lower Volga according to a study made in 1916 in the old Tsaritsyn District is shown below (Sashin, 1424):

Fruit orchards, berry orchards and vegetable-gardens were irrigated for an area of 933 hectares, and various field crops for an area of 1,642 hectares, that is, a total area of 2,635 hectares or 0.4 percent of the total arable land in the district. Rivers, gulleys, ravines, ponds and springs were used as irrigation sources. The distribution according to sources in the orchard and vegetable garden irrigated areas was as follows. 804 hectares were irrigated by rivers; 123 hectares, by gullies; 50 hectares, by ponds; 16 hectares, by springs; or a total of 993 hectares.

Water was supplied to the irrigated lands by the following methods: 1,575 hectares by regular natural irrigation; 1,015 hectares by regular mechanical irrigation; 11 hectares by simple estuary irrigation; and 34 hectares by tiers; or a total of 2,635 hectares.

For regular irrigation, 3,112 distribution canals (of total length 150 kilometers) and pipe canals (length about 80 kilometers) were constructed.

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Mechanical irrigation by bucket conveyers (chigir') and piston pumps was practiced to the following extent:

Name of the Pump Equipment	Power Source	Number	Average Height of Lift (in meters)
Bucket Conveyers	Horse-driven		
	Manual		
Piston Pump	Internal Combustion		
	Electric		
	Horse-driven		

The most common methods of watering were furrows, using infiltration (71 percent of the entire irrigated area) and, by "check" flooding of the area (29 percent of the area).

In natural irrigation, the average number of waterings was 10, the length of the period during which waterings took place was 50 days, and the norm for all waterings was 4,500--6,210 cubic meters per hectare; for mechanical irrigation, the corresponding figures were 7 waterings, 40 days, and 900-3,100 cubic meters per hectare. The number and norm of waterings varied according to the type of crop irrigated and the prevailing meteorological and soil conditions.

In characterizing the further development of irrigation, we should consider the study of the former Novouzensk Uyezd made by the Volga Regional Land Reclamation Organization in 1924-25; this study gave the following characteristics for the types of power sources used for mechanical irrigation on the 200 plantations studied (Kriger, 1384):

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Type of Equipment	Motor Locomobile	Bucket Conveyer (Elevator)	Grain Pump	Piston Pump	Siphon	Natural	Total
Number of stations							
Area irrigated (hectares)							
Capacity of stations (horsepower)							

The amount of land irrigated in the regions studied is shown in the following table:

Irrigation Possibilities

Name of Section	Irrigation Method	Irrigatable Land (Hectares)	Land Actually Irrigated	Irrigated Crops
Altatinsk	Estuary			Grain, truck garden, hay
Chertanlinsk	Natural from a pond			Grain, truck garden, hay
Veriblazovka	Natural from a pond			Grain, truck garden, hay, and fruit
Orlov-Gay	Estuary (liman), regular mechanical			Grain and truck garden
Piterka	Estuary, Bol'shaya Solyanka River			Truck garden
Peroshanka	Estuary, Bol'shaya Solyanka River			Grain and truck Garden
Mironovka	Estuary, Bol'shaya Solyanka River			Truck garden
Kozlovka	Estuary (liman), Talovka gulley			Grain and truck garden
"Sotrudnik" Artel	Natural			Grain and truck garden
Kommuna	Estuary (liman)			Grain and truck garden
Avgustovka	Estuary, Barzin Yerik			Grain
Kurilovka	Mechanical, Starka Gulley Natural, Talovka Gulley			Grain and truck garden Grain and grass

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The data cited does not cover the entire irrigated area of Nizhneye Povolzh'ye completely, but gives only some data on the development and character of water supply in the region. In summarizing the forms of water supply for agricultural use in the region, we can state that the methods used providing a water supply to the population and cattle in steppe areas where a shortage of moisture and fresh water prevails, consisted in the construction of wells and ponds, the latter being supplied by both ground water and surface runoff. The construction of ponds, i.e., reservoirs providing for retention of ground waters at a comparatively great height, increased the number and water content of springs, thus providing more uniform and stable discharge for rivers. Moreover, the evaporation from the reservoirs gave moisture to the air, thus creating the best conditions for the growth of farm crops.

Irrigation projects were carried out to bring new lands under cultivation and to increase the stability of farm crop harvests under drought conditions. The simplest method of using water was estuary (liman) irrigation, sections of land flooded by spring waters and retained by weirs and embankments. The latter served as an extension of the dam blocking the supply source. The spreading waters form a pond, i.e., a liman, from which they flow into streams and gullays after moistening the soil. According to the depth of the water layer in the liman, we distinguish shallow flooding, water 20-50 centimeters deep and deep flooding, water 100 centimeters deep. The use of flooding with a shallow layer is the better method, since for the same volume of water used we can irrigate a larger area, thus decreasing the swampiness and saline content of the soils by the installation of liman "layer" irrigation in a number of regions. In this method, the section is divided by

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dams into separate layers, i.e., estuaries situated one below the other. The water, after filling the upper layer, drops through the floodgate into the lower estuary, and from the latter into rivers and gulleys. The water stands in a liman for an average of 10-15 days. The defect of liman irrigation, other than swamping and silting of the soil, is that the water is supplied to the section only once, in the spring. The lands irrigated by limans are used mainly for meadows and hay, but in many places where more refined methods are not available, grain crops are also planted with liman irrigation, giving 3-4 times higher harvests.

The best irrigation method for a region is a regular irrigation network, both, by being introduced in new localities, and by conversion of liman irrigation in experimental sectors. The water is supplied from a reservoir either naturally or mechanically. For mechanized lifting of water, bucket conveyors (chiligir'), chain and piston pumps, siphons, etc., are used, operated by power sources, locomobiles, or manually. The water is fed by power sources or gravitation into the supply canal and then into distributors and irrigators, irrigating the field either by infiltration along furrows 35-50 centimeters wide and 12-17 centimeters deep, or by the flooding of small areas (chekl, plankl) from 2 to 20 square meters in size depending upon the crop. The water is distributed by means of pipes, floodgates, sluices, regulators, etc. Grain, vegetable and grass crops utilize regular irrigation systems. In regular irrigation, the number of waterings and their times and norms are established for the type of crop irrigated, the soil condition, and the amount of rainfall.

The amount of land under irrigation and its distribution with respect to irrigation methods within the administrative boundaries of

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the former Nizhne-Volga Kray (not including the German-Volga ASSR) is shown as of 1 September 1931 in the following table:

Used	Area of Regular Irrigation (Hectares)						Area of Liman Irrigation (Hectares)			Total		
	Natural			Mechanical								
	Active	Inactive	Total	Active	Inactive	Total	Active	Inactive	Total	Active	Inactive	Total
By sovkhozes and the TSUK												
By kolkhozes												
Total												

In addition, there were registered for the German Volga ASSR, 19,000 hectares of areas under active irrigation. All in all there is a total of 94,222 hectares of active and inactive irrigated areas in the Nizhne-Volga Kray.

Regular irrigation for fruit, vegetable, and technical crops is used predominantly on the right shore. On the left shore of the Volga, both regular and liman irrigation are used to an equal degree. In the northern part, artificial limans are used for cereals, while in the southern part, topographic and runoff conditions make available natural limans, which are used mainly for hay.

It is necessary, however, to point out again that irrigation developed at an exceedingly slow rate in the lands along the Volga before the Revolution (and then primarily on government-irrigated areas, to a slight degree on privately-owned land, and, as exceptions, on peasants' holdings). Thus the Soviet economy had to take an entirely new start in

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approaching the problem of irrigation in the Volga region. An analysis of data for 1931 for the Nizhne-Volga Kray (in administrative boundaries) shows that the irrigated land area was only 0.3 percent of the total kray area or 0.4 percent of the total land area used for crops and hay. This insignificant amount of irrigated land, with the existing hydrometeorological conditions and frequent droughts, cannot provide sufficient productivity and stability for agriculture and animal husbandry in the region from the standpoint of the goals of the Second Five-Year Plan and the general economic plan, which envisages the transformation of this area into a large grain growing base.

The decree of the Central Committee of the Communist Party of 15 February 1930, dealing with the Volga-Ustyug project both from the power and irrigation standpoint, can be considered the beginning of real work with respect to irrigation in Nizhnaya Povolzh'ye.

The plans drawn up by the Kray committees and Kray executive committees s ecified that by the end of 1937 the irrigated area should be brought up to 1,500,000 hectares within the administrative boundaries of the Srednc-Volga Kray and to 1,443,400 hectares within the administrative boundaries of the Nizhne-Volga Kray.

A. V. Chaplygin's plan for irrigation of the trans-Volga, which was discussed in the League for Water Economy (Soyuzvodkhoz) of the People's Commissariat of Agriculture USSR in 1930, was the first to envisage complex utilization of Volga drainage for purposes of irrigation, power, and transportation, along with the parallel utilization of local drainage. The plan provided for the irrigation of up to 1,950,000 hectares in the trans-Volga by the construction of dams at Samarskaya Luka at the confluence of the Yeruslan River.

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In conclusion, we note that the problem of irrigation of the trans-Volga has now been decisively solved in the affirmative by the Decree of the Council of People's Commissars USSR and the Central Committee of the Communist Party of 22 May 1932. This decree provided for the irrigation by 1937 of a cultivated area of 4 to 4.3 million hectares to create a durable wheat base in the trans-Volga with an overall production of 50 million centners of wheat on irrigated land, along with the use of the Volga as a large power base and transportation medium. This immense problem is also of a complex nature and will be discussed in more detail in the section on complex water economy measures.

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5. Fishing and the Fishing Industry

Ichthyo-fauna of the Lower Volga

Nizhnaye Povolzh'ye includes the section of the Volga from the confluence of the Kama to the Caspian Sea. From the standpoint of ichthyology, only the Volga delta, and, in part, the Akhtuba bottom land differ from the Volgograd. Twenty-seven industrial fish species form the basis of fishing in the Volga-Caspian area, the leading fishing area of the Soviet Union. This illustrates the significance of Nizhnaye Povolzh'ye in the country's fishing industry. The northern part of the Caspian Sea and the Volga bottom land are related to each other by the peculiarity of the biology of migrating fish. In view of this, it would not be logical to make a formal distinction between the river and the sea, otherwise, two parts would be separated, which, as a whole, contain all the characteristic features comprising the industry and biology of estuary and migratory fish. In evaluating the industry and production of the lower river and the adjoining part of the sea, insurmountable difficulties are encountered when attempting to single out the Volga-Caspian area, in the near meaning of the word. Up to the end of 1931, the catches of the Ural River and the Ural-Caspian region were not listed separately, but were included in the overall statistics for the Volga-Caspian fishing industry region. Because of this, the great majority of the tables included below, do not attest to the fishing significance of the Volga, in the geographical sense of the word, but refer to the significance of both the Ural and Volga regions taken together. However, as a result of a study of the Ural in 1932, some data are available which give a partial picture of the significance of the lower Volga

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area in the overall industry of the region.

The Volga is a separate zoo-geographic portion within the Caspian istrict of the Ponto-Caspian Aral province. This portion includes the basins of rivers which flow into the Caspian Sea to the north of the Kura. Of 68 species of fish which inhabit the Volga basins, 60 species are found in the region under discussion, among which the endemic species are absent. In the Volga proper, 42 species are found, of which 29 are commercial. In the delta region the following are also to be found: a group of herring, goby, vobla, barbel. The ichthyo-fauna of the lower Volga area includes 60 species of fish, which belong to 13 different families; 39 of these species are commercial. The non-commercial include: brook lamprey, the small sturgeon (ship) Charkhal herring, "shipovka," ground gudgeon, gudgeon, "kutum," barbel, "ribets," minnow, "verkhovka," "pomoshka," needle-fish. The goby fish are now being utilized commercially (canned fish).

Volga fish can be classified into three biological groups: (1) Migratory fish that grow and feed in the sea and only enter the Volga and other Caspian rivers for spawning at the time of sexual maturity. Some migratory fish, such as the whitefish, travel some three thousand kilometers into the uppermost reaches of the Volga basin. The migratory fish include: lamprey, sturgeon, Caspian salmon, whitefish, herrings: blackback, Volga herring (ordinary), North-Caspian shad, Suvorov shad Caspian sprat, and "vobla." After spawning they return to the sea (all with the exception of the black-back and Volga herring). (2) Semi-migratory fish, i.e., deep hole or estuary fish which also make seasonal but limited migrations in the delta region. Their outstanding characteristic feature is that they stop feeding in the fall, become rather immobile, spend the winter in deep places (fish holes), and gather in

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very large schools in the lower part of the river. In order to prevent the destruction of these fish reserves, a law dating back to 1865 prohibits fishing in these reserves. Fishing in these reserves, which was carried out for several years after 1917, resulted in the decrease of the number of semimigratory fish. Typical representatives of this group are: carp, pike, sheatfish, and partially, the pike perch, "bersh," zherekh, a carp-like fish, "gustera," "sopa," (Abramis ballerus), "beloglazka," [white-eyed fish] (Abramis sapa), and "chakhon." These fish enter the Volga delta in the spring for spawning. Until the water begins to go down, the adult and young fish remain at the spawning grounds (poloya), where they feed actively, and after which they return to the sea, remaining in the immediate coastal strip. (3) Local water (tuvodnyye), river or resident fish, which do not leave the river at all, do not carry out mass movements or migrations, and do not have great significance. To this category belong the sterlet (small sturgeon) which, until the late eighties, existed in the delta area in great numbers but which was practically exterminated with the development of fishing, and only began to increase in number again when limitations on fishing were established in 1919. To the same group belong: "serushka," burbot, ide, perch, pike, Prussian carp, and others.

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The Fishing Industry in the Region of Large-Scale Fishing

The industrial river basins of Nizhneye Povolzh'ye abut on the sea and form an organic extension of the northern Caspian area. The greatest part of the fish catch is obtained in the Volga delta and this shallow part of the sea which adjoins the river. The amount of the fish catch in the Volga-Caspian region reaches an average of 4,000,000 centners, counting the Lower Volga area. The river catch of the Volga delta and the Ural area reaches 1,300,000 - 2,000,000 centners. Further up the Volga the quantity of fish reaches only 150,000 - 170,000 centners. The commercial value of local water fish has been increasing in importance. That, together with the reduction in the size of the catch, serves as the basis for the classification of this region as one of small catches. The Volga delta, together with the adjoining parts of the Caspian Sea, form a scale fishing region. Before the war, the region of large-scale fishing extended all the way to Kamyshin. Since then, the limits have moved down, so that by 1931 the northern limit of the large-scale fishing region was located at Zan'yany, 70 kilometers above Astrakhan'.

The ration of the catch for the region of large-scale fishing (the Volga delta) to that of the region of small-scale fishing is 10 to 1.

A characteristic feature of the development of Volga fishing is the fact that catches from the region have decreased in a down-stream direction, up to the delta, at which point the fishing in the sea began to assume commercial proportions. The imperialist war, the Revolution, and the interruption in the development of the fishing industry which followed, created conditions under which the river catches temporarily

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outweighed the sea catches, but later on the prewar ratio again re-established itself. At the present time, government fishing, organized as a trust, is based mainly on a series of installations on the many banks (shoals) of the Volga delta in the direct path of each wig of commercial fish. In addition to the trust industry, the fishing kolkhozes are engaged in commercial fishing.

In order to judge the utilization of the lower Volga area as a commercial fishing basin, it is necessary to examine the dynamics of the catches during the various development stages of the industry. The difficulty of separating the river catch must be noted, as the sea and the river in the Volga estuary have no borders and the transition takes place imperceptibly. The period before the 19th war is characterized in the next table by L. I. Gurvitch (1673).

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The Fishing Industry in the Small-Scale Fishing Region of the Kuibyshev-Volga Area

The small-scale fishing region of the Kuibyshev-Volga Area includes all basin areas with the exception of the Volga delta. Included are the Volga system, from the Kuibyshev-Volga Area border up to and including Zav'yany as well as the Don system, with the tributaries Khopr, Medveditsa, Ilovla, and others. Exploitation of the basins of the small-scale fishing region is carried out by the Kuibyshev-Volga Area Fishing Kolkhoz Cooperative, which is the largest commercial fishing organization, the kolkhozes of the Volga German republic, and the Fisheries System of the Consumers' Cooperative.

Assessing the fish production derived from this region is somewhat difficult because of incomplete statistical data. Fishing installations scattered over a large territory, unproductive methods, the fact that a considerable percentage of the catch remains with the fishermen or finds its way to private markets, considerably reduces the size of the commercial catch.

Prewar data on catches apply only to the section between Saratov and Stalingrad. They are indicated below (Reports of the Fisheries Administration for the years 1909-1915):

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Lake Baskun'chak

Lake Baskun'chak is situated 240 kilometers north of Astrakhan' by railroad. The industrial salt centers are also connected by sea-route, the terminal of which is the Vladimir Landing on the Volga. Baskun'chak is currently the leading area of the region in yield of natural table salt. In 1931 there were in the lake area three installations active in salt production: two of these were of the dredging type, and one was a salt pump. All three systems operated on the principle of subsequent washing with natural brine.

The following data on salt production and net plant cost are presented to illustrate the rise in salt production of the Bas-Sol' Trust:

	Salt Production in Thousands of Tons			Plant Cost
	Mechanical	Manual	Total	Kopeks per ton
1927 - 1928				
1928 - 1929				
1930				
1931				

The brine in Lake Baskun'chak is free of sulfates; consequently, its layers of salt, formed annually by evaporation of the brine, contain no sulfates; thick salt reserves are found at the bottom of the lake, and annual salt deposits are formed, the lake being fed by salt rivulets. Brine of 25-28 percent salt content (73 percent NaCl; 2,2

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percent $MgCl_2$; 2.4 percent $CaCl_2$; 0.1 percent $CaSO_4$; 0.22 percent $MgSO_4$), yields a salt of excellent quality which, after washing has the following composition: NaCl - 98-99 percent; $MgCl_2$ - 0.1 percent; $CaSO_4$ - 0.2-0.5 percent; insoluble components - 0.1-0.3 percent.

The layers of salt, formed by evaporation of the brine, are 4 to 8 centimeters thick. Below that, there is a compact layer of crude salt, 35 to 60 centimeters in thickness (up to 150 centimeters); in parts of the lake (3% percent) - there are thin layers, interbedded with layers of silt. The most valuable sodium chloride dry tails are found under the crude salt layer: a porous, easily accessible, pure layer more than two meters thick, which becomes more compact, crude-salt-like, 4 to 6 meters in thickness. Beyond that, there is a layer of clay, 12 meters thick, then again salt for 2 meters, again 12 meters of clay, and beyond that a stratum of salt has been discovered (but its end has not been reached) of at least 10 meters thickness (evidently rock-salt). The upper layer alone represents a reserve of 320 million tons of salt; when the additional layers are added, the total reaches 1,560 million tons.

Seventy-five kilometers to the southeast of Baskun'chak there are rock salt deposits in Chapchach, comprising a minimum reserve of 96 million tons of salt, containing 99.75 percent NaCl (residue: insoluble substances and water). Only the distance of the railroad and the fact that pure salt is found in Baskun'chak explain the reason why these qualitatively outstanding deposits are not being exploited.

Extraction of salt from Lake Baskun'chak was started in 1711 and continued with several interruptions until 1806. Later, the Baskun'-chak salt industry began to develop after 1865 and rapidly exceeded production of Lake El'ton. In 1914, there were 1,536 workers employed in

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Baskun'chak out of a total of 1,641 salt workers in the Astrakhan' salt industry. Extraction of salt begins in April, May, or June, and continues into October or November (Tur'yan, 1927); the most important period in salt extraction is that between July and September. Transport of the salt, before construction of the Baskun'chak railroad spur, was effected by land to the Vladimir Landing (on the Volga). At the present time, the salt is transported here by the railroad spur mentioned above, while 97 percent of it is transported from here by water. The salt is ground at Vladimir Landing, and is shipped from there already sorted.

With regard to quantity of salt produced, Lake Baskun'chak is one of the richest salt producing lakes not only for the USSR but also for many other countries. In certain years, salt production of Lake Baskun'chak represented as much as 31 percent of the entire Russian production (in 1912), and as much as 96 percent of the production of the Astrakhan' region. Baskun'chak salt is of the highest quality and has great significance in the salting of fish. The Volga-Caspian fish industry uses up to 16,000 tons of salt annually. Finely ground Baskun'-chak salt is used for salting caviar and is even transported to the Far East for that purpose. Part of the salt which is shipped out by rail, is ground in salt grinding mills near the lake. The development of salt extraction in Lake Baskun'chak from 1867 to 1927 is illustrated in Figure 10b.

Salt extraction during the prewar years was carried out entirely by manual process. A far-reaching mechanization project for the salt industry had been worked out in 1918, but mechanization was begun only in 1921. During that year, a salt-pump was installed, and later on an excavating installation was introduced. During the initial years

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(1924-1925), only 1.6 percent of production was obtained by mechanized means, during the next season (1925-1926), mechanized production comprised 5 percent of the total and, in 1926-27, 23 percent of the total production (114,000 tons) was obtained mechanically. About 3,000 workers, from among the local Kirghiz nomads, were employed in the manual extraction of salt. Net cost of one ton of salt, extracted manually, was 2.70 rubles; this was reduced to 1.23 rubles per ton by mechanized production. Impurities in the product, derived by mechanized process, were reduced from between 0.33 to 0.65 percent to 0.12 percent. With manual production, salt was extracted from a depth of only one-half meter of the salt layer. With mechanized production that depth was increased to 3 meters. Mechanization of salt production, in addition to the salt pump and extraction machinery, extends also to shipping, as well as to the washing, drying, grinding, and sorting.

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8. THE DESTRUCTIVE ACTION OF WATER AND MEASURES TO COMBAT IT

Floods in the Lower Volga basin are caused by: the high water in the spring resulting from melting snow in the basins of the Upper and Central Volga and Kama rivers; the fall high waters resulting from prolonged rain, emanating from the same areas; floods in the Volga Delta are also caused by driving winds. The principal reason for floods are the spring high waters, the crest of which has been known to rise, in exceptional cases (1926), as high as 12-13 meters, and even higher. As a rule, spring high waters, which do not exceed a certain limit, do not cause great damage and suffering to the population; on the contrary, the flood waters which spill across the fields are beneficial to the hay crops. However, during exceptionally high spring floods, such as occurred in the years 1914, 1915, 1916, 1917, 1919, and 1929, there were certain points which were completely inundated, causing great damage to shore installations, warehouses, washing away embankments, etc.; the lower part of the town of Engel's was inundated. A serious flood usually affects shipping facilities greatly: it carries away landing piers, inundates living quarters of personnel and interferes with transport of employees by boat. During the exceptionally high spring floods in 1926, the damage done was extremely high. In 1926, correspondents of the Hydrological Institute, who lived near the Volga river, reported that there were floods everywhere, including villages which did not usually suffer spring floods, inundations of arable land, of washed-out embankments and highways. In the vicinity of Samara, Syzran', Saratov, and Stalingrad, railroad trestles were washed out; in Samara, Vol'sk, and Kamyshin, streets near the river were inundated.

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In the Volga Delta area and in several places above it, the inundation of populated localities in low areas is customary during the high spring waters; embankments are also usually washed out. On the Lower Volga, where the spring floods caused by waters coming from the upper part usually last from 4 to 6 and more weeks, the suffering caused by the flood is aggravated by the fact that this flood occurs in the second half of May and in June, at a time when, in accordance with local climatic conditions, grain has already been planted, as have vegetables and melons.

The population on the Lower Volga protects its settlements and agricultural installations in low areas by dykes (Kharabali, Yenotayevsk, Petropavlovsk, Raznochinsk, Karaguchev-Darak, Verkhnyy, Balakley, Teplinskoye, Astrakhan', and others). The building of dykes has been practiced in the Volga Delta area for many years. There are records of the existence of protective dykes as far back as the second half of the eighteenth century. At the present time, the building of dykes is still carried on actively in the Volga Delta, but for purely agricultural purposes. Based on research done by V. Meysner [167] in 1914, the area of walled plots in the delta comprised 42,000 hectares, which amounts to about 6 percent of the entire Volga Delta area. If the western Il'men area where damming is not extensively developed, is to be excluded, the percentage would increase to 7.5 percent. Based on the same investigation, the length of the dykes reached 677,000 meters, and their cost approximately 1 million rubles [Valedinskiy, 276].

During the imperialist war, the walled area decreased considerably, and began to develop again only after the Revolution; based on data of the OkrZU, the dammed-off area reached 38,000

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hectares in 1926, but these data must be considered incomplete. At the present time, the practice of building dykes continues to develop and it is related to the so-called Volgo-Akhtubinsk problem, which consists of the utilization of the Volgo-Akhtubinsk bottom land, which is inundated during the floods, and of the Volga Delta, for intensive irrigation farming which is possible only after the accomplishment of flood control measures. It must be further noted that future development of damming in the delta area is closely linked to the protection of the fish industry interests, since the dammed-off areas are excluded from the fund of non-spawning areas of the fish industry.

Protective dykes in the Lower Volga area are simple earth dams which are sufficient protection against normal high waters, but which frequently give way during severe floods. For instance, in 1926, orchards were inundated and damaged in Yenotayevsk because protective dams had given way. In Petropavlovsk, a portion of the buildings in the unprotected part of the town is inundated during high flood waters. During the years of extremely high spring floods (1914 to 1917), protective dams were destroyed, buildings were damaged, and the entire community was inundated. In 1926 all buildings were flooded, even those in relatively high locations. During the same year, protective dams were also destroyed in a number of other settlements.

Astrakhan's lower areas are also protected against floods by dykes in the form of simple earth dams. In 1926 extensive reinforcing, and the mobilization of large numbers of community forces were necessary in order to protect the town from the threat of inundation. The protective dams were shored and raised in height, and new protective

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dams were built in some areas. The city was saved, but the surrounding countryside suffered heavily. Equally dangerous for Astrakhan' were the high spring waters of 1914 and 1915 when the dams had to be reinforced against washouts.

The fall high waters of the Lower Volga (caused by prolonged rains) are insignificant in comparison with the spring floods. Exceptionally severe fall floods, such as were experienced in the years 1880, 1905, 1916, 1926, and 1927, still have a lower crest than the lowest spring flood; nevertheless, they caused considerable damage by their unexpectedness (they occur infrequently and are not caused by local [illegible] reason is that they occur duri[illegible] year when the hay has been gathered in the fields and grains are almost ripe, lumber has been stacked along the river banks, etc. In order to prevent serious consequences of fall floods, timely warning of the population is essential, and is entirely possible since these fall floods on the Lower Volga are the result of extensive prolonged rains in the large territory of the upper part of the Volga basin.

A third reason for inundations in the Volga Delta are driving winds, as a result of which, in the case of high waters, fishing installations are inundated (sheds, fishing gear, etc.), and hay is carried away by the flood waters.

The principal driving winds are those from the southeast and the east. An additional favorable condition for the rise of the waters driven by the winds is the fact that the water level is not high in the Astrakhan' valley. Driving winds usually occur in April, September, October, and November. The strongest driving winds are observed most frequently during April, October, and November. The

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periods of greatest intensity were those between 1870 and 1880; the most quiet period was that after 1910. During a 52-year period (1877 to 1917, 1919 to 1929), there were 21 floods in excess of 79 centimeters caused in Astrakhan' by driving winds; the highest one occurred in 1910 and its crest reached 133 centimeters.

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From the standpoint of irrigation, the important thing is that the water reservoirs, after installation of electric pumping stations, represent sources of irrigation water for the territories of the Trans-Volga area where the irrigation capacity of local channels (Uzen', Karaman, Yeruslan, and the tributaries of the Irgiz) do not exceed 150,000 hectares. Initial irrigation of 4 million hectares, from the Kinel'-Samara area to the north, and parallel with the town of Kamyshin to the south, requires nearly 20 cubic kilometers of water annually, as compared to an annual water flow capacity of the Volga in the vicinity of 250 cubic kilometers during an average year. Such a correlation of expenditures makes possible the establishment of a water economy regime which satisfies the demands of both irrigation and water transport. Dry territories between the Samara and Kamyshin parallels, earmarked for irrigation, rise about 50 to 100 meters above the level of the Volga. The problem of raising the water to such a high level obviously requires a specialized technological solution. In this case, it is proposed to pump water from the Volga, not directly into the irrigation system, but into water reservoirs in several high points on the territory to be irrigated, which makes it possible to have the pumps work for irrigation purposes not only during the irrigation period (in the Volga area that period lasts only 100 days), but also during the course of the entire year, which circumstance permits use of pumps of considerably lower capacity. Costs of installing water reservoirs will not be very high because of favorable hydrogeological conditions and the simplicity of installing earth dams without spillways in a dry area. The necessary power

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output for irrigation, according to preliminary data, will be 5-6 billion kilowatt hours.

The economic significance of the irrigation aspect of the Greater Volga problem is quite clear, and the necessity for the fight against drought to which the Volga area has been subjected makes it imperative that this side of the question in particular be solved; this has been recognized in the Decree of the SNK USSR and the TsK VKP(b) of 22 May 1932, which set forth measures against drought in the regions of the Trans-Volga area and envisaged the establishment in that area of a stable wheat base with a production of 300 million pods of wheat from the irrigated land, the irrigation by mechanized means of a planting area of from 4 to 4.3 million hectares in the Trans-Volga area (the Central Volga, including the Kinel'-Samara areas to the north, and the Lower Volga to the Kamyshin parallel to the south).

The irrigation is planned on the basis of power generated by the Kamyshin Hydroelectric Station, capable of an output of 1.8 to 2 million kilowatts, whereby the interests of water transport must be fully taken into consideration.

The urgency of the irrigation problem in the Trans-Volga area, as well as the question of power in the Upper Volga area, stimulate the start of reconstruction of the Volga simultaneously at its lower and upper parts where construction of two stations -- one in the Ivanovo-Voznesensk area, and the other in the Gorkiy area -- is envisaged in the Decree of the SNK USSR and the TsK VKP(b) of 23 March 1932. From the viewpoint of water transport, both the completion of the intermediate portion as rapidly as possible, and the completion of full reconstruction of the Volga are desirable.

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It is essential, however, to note that there are as yet no concrete plans for the various constructions; the above projected construction scheme is not final and requires additional study and consideration of all consequences which the completion of this project may entail. Such possible consequences would be, in part, rather large inundations of land and, in certain areas, the rise of ground waters and swamping of certain areas. As a result of construction of the Kuybyshev dyke, the incidence of landslides may also be expected to increase, whereby not only the already loosened land masses could be set in motion, but also those which had hitherto not been subject to landslides. In particular, landslides can be expected to occur in the area from the Yeruslan estuary to Saratov; from Volsk to Khvalynsk, and from Zhigulyve to Tetyushi (Chaplygin, 2189).

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INUNDATED MEADOWS IN COMBINATION WITH UNDERGROWTH AND TREES

The vegetation of the river valley, designated on the map by one number for the entire area of the European USSR, is concerned with a number of the most widely distributed plant groups. They are being cultivated in all zones and all geographic areas. However, ~~it~~ vegetation is quite a bit more incompletely homogenous throughout the European USSR, having been subordinated in its development, both by the general lines of zonation, and by special features connected with the historic development of vegetative cover and with the economic activities of mankind. Every river valley is also heterogenous within itself. According to V. R. Williams' theory, the characteristics of the formation of river valleys (in which the river bank, the central and the terrace areas may be distinguished, in addition to regions with very large accumulations of gravel and temestial sand dunes.) are determined to a large extent, by the characteristics of the territory through which the river flows, and by the vegetation covering this territory (forests and marshy areas, on the one hand; and a treeless expanse, on the other hand). Also, there are undoubtedly several peculiarities which distinguish the vegetation of the river valley in different zones: tundra (e.g., the lower regions of the Pechora), taiga (greater portion of the river valleys of the northern half of the European USSR), broad-leaved, forest-steppe (the river valleys of the Sula, Oka, Sura, Belaya, Sviyaga, middle Volga, Dnieper, upper Don, etc.), steppe (river valleys of most rivers in the southern part of the territory), and desert (lower regions of the Urals, the Volga, the Terek, the Kura, etc.). River meadow formations are principally composed of plants which have undergone continuous flooding and partial snowdrifting.

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In the river valleys of the steppe zone, there is said to be an even sharper variability in the humidity, and in addition to this, the smaller rivers are noted for their salt consistency. Floods in these valleys are neither big nor prolonged. The soil, having been washed along by the water, is salted by the rising flow of the ground water. Solonchak marshes and meadows are being developed in the depressed areas, while solonetz steppes and meadows are being developed in the higher areas.

In the valleys of most rivers which flow from the north (Don, Volga) or from the mountains (Kuban', Terek), floods are big and prolonged; salinity is considerably lower; conditions are dry only on the high crests. The vegetation is similar to that of meadows in the forest steppe zone. Woody vegetation is represented by osier-beds (Salix triandra, S. purpurea), white willows (Salix alba), black poplars (Populus nigra), local white-leaved poplars (Populus alba, in the eastern part of the foothills of the Caucasus - P. hybrida) and also by elm-oak trees of Ulmus glabra and U. laevis with Quercus robur. In the gravel deposits of Caucasian rivers oblériki undergrowth (Hippophaë rhamnoides) is being developed; Myricaria germanica is also often met.

On the crests of the river valleys of the steppe zone are cultivated — [the following] grassy plains with marsh rosemary (Statice tomentella) and wormwood (Artemisia Salina); meadows with ~~tipchak~~ fescue and yellow lucerne (Medicago falcata), steppe sedge (Carex praecox), elecampane (Inula cordata) and others; grain steppes and steppe meadows of Agropyrum pectiniforme, together with licorice (Glycyrrhiza glabra), ~~tipchak~~ fescue, wormwood, camphor, smartweed (Acroptilon picris) and others.

In the valleys of the big rivers, varieties of coarse quackgrass meadows have been widely developed and consist of Agropyrum repens together with Bromus inermis, Calamagrostis epigeios, Rumex confertus, Artemisia procera and others, as well as Kostrov, beach grass and quackgrass river bank meadows with a small number of grassy varieties; Solanchak fescue grasses, and foxtail grass meadows with Festuca arundinacea, Alopecurus ventricosus and Puccinellia

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distans s. l.; and lastly, swampy meadows -- reed, rush and others, as mentioned before (Pages 167-168)

On the dry steppe and desert areas (delta of the Terek and sections of the Kuban, lower Kura and Araks) the bottomland overgrowth of weeds is usually represented by varieties of grebenchak (Tamarix ramosissima and others) and oleaster (Elaeagnus caspica, E. angustifolia). Here there is the following large diffusion in the composition of grassy meadow vegetation; perennial, long, rhizomatous Bermuda-grass (Cynodon dactylon) and such annual grasses as Phleum paniculatum, Digitaria sanguinalis, Echinochloa crus galli; rarely met in the Transcaucasus and in the eastern foothills of the Caucasus are these spectacular coarse grasses: Imperata cylindrica and Erianthus purpuraceus, which produce taenosy of the savannah type.

River valley meadows are the principal natural fodder lands in the European USSR.* Their area occupies several million hectares; the harvest on coarse-grass meadows yields and average of 20 to 30 centners, on the fast growing brushwood along the river banks -- 40 to 60 centners, on the fine-grass meadows -- 8 to 10 centners. This harvest can be raised considerably by the proper application of farming principles in these meadows. A large part of the meadows is extremely choked up and, to a large extent is stagnant, and in the pasture areas is covered with small hillocks. The following improvements are needed: drying and draining the swampy areas of the river valley; fertilizing the barren meadows on a big scale; strengthening washed out areas along the river bank; cleaning out weeds; modern pumping out of the meadows; and a proper system of cultivation. Planting trees and overgrowth along the river banks and the development of seed crops, haying, pasture lands, gardens, orchards, melon and technical crops along the banks, in conjunction with the high quality natural meadows in the middle portions of the river valleys.

* Footnote on page 166:

A large part of the present river valley meadows is either of secondary origin in the locality of a dense forest, or, thanks to hay-cutting and

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cultivation, is being maintained in localities which had been occupied by a forest (without this influence). A sizable portion of the river valley is used for gardens and other crops. The huge massifs particularly those denoted in Paragraph #43 in the deltas of the Kuban and Terek, are represented at the present time by wide fields, sown with wheat, sunflowers and other crops.

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Solonchak-meadow and Sononchak-marsh vegetation in combination with halophytic (Solyankoviy) and steppe fitotsenoz ("razdivi" estuaries" "drying plavni," and chal'naya vegetation")

In this category are united mixed combinations of vegetative societies, having developed in localities with a temporarily excessive and later a killing dampness, plus an increasing soil salinity which led to the formation of solonchah soils. Such fitotsenozy have been widely distributed throughout the river valleys of the steppe and desert zone, and also throughout the drainage and non-drainage depressions. On the map were illustrated only the larger massifs at the deltas of the Kuban' and Terek, on the lower Kura, Araks, Sulak, Kama, in the area of Bol'shoy Manych, in Chishinskiy razliv, in the valley of the Bol'shoy and Maliy Uzen, in the flat western Kamysh-Samarskoye, Sarpinskiy, and other lakes of the Northwestern and northern outlying districts bordering the Caspian lowlands. This category can also be shown in great detail in the outlying districts of the plavni on the Don, the Volga, the Duna, the Dnestr, etc., but there the corresponding contours seemed to be so fine and narrow that they appear depressed. Vegetative mixtures here, for the most part, consist of solonchak varieties of marsh and steppe-meadows. To these are added the non-solonchak meadow marshes located in the most intensively and permanently damp lowland areas. In the saltiest soils are the various Solyankovy concentrations. The improved areas, dried and often coverted to Solonetz, are occupied by steppe vegetation (for the most part, however, they have been plowed up). In many cases, zonal or circumferential distribution is characteristic of such tsenozy, in a different degree of dampness and salinity.

A plentiful supply of spring water forms the principal habitat of this type. This water remains for a considerable time in the flat lowland areas, having slowly drained off the slight slopes of the area, and having formed the so-called "razlivy" and "plavny." It stagnates in the flat, closed-off depressions, which have received the name of "plavny" and "pody."

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Limany and pody, having been scattered in a single or sometimes dispersed in a little chain according to the overall lowness in the topography, occur either quite small or attain huge dimensions, several thousands of hectares in area, in contrast to water-collecting areas.

The soils, having developed in conditions of prolonged flooding, react towards solonetz and solonchak by often passing over into the saline state (osolodel').

In the northern Caspian area, these associations of meadows are being developed, for the most part: quackgrass (Agropyrum repens), bekmanniev (Beckmannia eruciformis) beach grass (Calamagrostis epigeios) kostrov (Bromus inermis), vodolyubov (Heleocharis palustris s.l.), akmamykov (Puccinellia distans s.l.) and other meadows; some pure or more often mixed meadows are: vodolyubavo-quackgrass, kostrovoliso-khvostovo-quackgrass, etc. Among the predominant areas of meadows encountered are sections of the steppe and desert class of meadows, plus the variegated transitions occurring between them.

Often in the central, the deepest parts of the limany and in the depressions between the razlivy and the dried plavny, are found dense, high thickets of reeds (Phragmites communis), club grasses (Scirpus lacustris, Bolboschoenus maritimus) and cat-tail flag (Tupha angustifolia) and even planktonic plants, in instances of water stagnating throughout the entire summer. In the North Caucasus, meadow-bog vegetation mainly consists of tall thickets of reeds (Phragmites communis) to which are added Bolboscheonus maritimus and Scirpus Tabernae-montani.

Solonchak meadows in the North Caucasus are composed of the Solonchak form of quackgrass (Agropyrum repens, types of beskil'nitsa (Puccinellia), bekmanniev (Beckmannia eruciformis), salonchak foxtail grass (Alopecrus ventricosus), beach grass (Calamagrostis epigeios), rush (Juncus Gerardi) skrytnitsa (crypsis aculeata and C. schoenoides), together with marsh rosemary (Statice scoparia, etc.), licorice (Glycyrrhiza glabra), sea wormwood (Artemisia maritima salina), iris (Iris halophila and I. notha) etc.

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In the outlying districts of the Azov-Kuban' limany are developed short-grass meadows, composed of such varieties as Cyperus (C. fuscus and Acorellus pannonicus), together with such weeds as: Agropyrum repens, Agrostis alba, apera spica venti, Puccinellia convoluta s. l., Crypsis aculeata, Cr. schoenoides, Eragrostis poaeoides, Hordeum geniculatum etc., with such short legumes — Lotus praetermissus and Trifolium fragiferum, together with Spergularia marginata, Potentilla reptans, Erodium circutarium, Plantago salsa, Pl. teniuflora, Inula britannica, Pulicaria vulgaris, etc.*

The vegetation of the solonchak pyaten are represented by the glass-wort (Salicornia herbacea) varieties of Salsola, Suaeda, Camphorosma, and sometimes atriplex verruciferum and Halocnemum strobilaceum.

Chal'naya vegetation in the lower regions of the Kura and Araks comprises a large number of the following combined individual varieties of coarse pyaten (of the thicket variety) which cover an area having a different degree of salinity and dampness: Bermuda grass (cynodon dactylon), pribrezhnitsa (Aeluropus repens), beskil'nitsa (Puccinellia gigantea), reeds, alhagi (Alhagi pseudoalhagi), licorice (Glycyrrhiza glabra), marsh rosemary (Statice scoparia), mimosa (Lagonychium faretum). In the most arid areas are developed dried tsenozy with wormwood (Artemisia Szovitsiana) and solyank shrubs (Salsola dendriodes).

Vegetation of the solonchak meadow-bogs and mixed meadows mixes are used for haying and partly for tilling (fine-grass meadows); solyank and wormwood concentrations are also used for tilling (in nature of winter pasturing).

* Footnote on page 175:

On the map, #46 has been represented only by the southern group of limany, where salinity is more intense; solonchak-bogs of fitotsenoz surround the limany of the northern group where #43 has been presented incorrectly instead of #46.

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Steppes

Numbers of the legend from 53 to 59 essentially characterize the zonal or flat, restored vegetative cover on the cultivated territories. In the lowlands, these steppes were preserved as national reservations including lands used for horse breeding and slopes of ravines. In the mountains, steppe vegetation, naturally has been preserved over a large territory.

Pg 190 Meadow steppes and steppe meadows.

(#53) continued) Harvest of steppe meadows and meadow steppes, which are in a state of good preservation, is about 10 to 15 centners per hectare, the quality of which depends upon the composition of the grasses; a satisfactory harvest of hay is quite often obtained as a result of timely sloping. On intensely developed areas: 5 to 6 centners of dry mass per hectare is obtained.

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63: Grassy - wormwood steppe-deserts (typical wormwood deserts, usually mixed with typical feather - grasses and typical steppe and wormwood and solyank deserts) (63p, 63; 63t and 63h)

Grassy wormwood steppe-deserts are the most diversified variety, being represented by coarse contours in the northern podzone of the desert region and by relatively smooth contours in the deserts of the foothills of the Caucasus and the Transcaucasus and along the Caucasian coast of the Caspian.

In addition to their predominant role in the association structure of grass varieties, fine turf steppe grasses, along with the xerophyte grass variety, are of significant importance.

The Combination (Kompleksirovaniye) of sections of various desert classes with steppe associations creates a typical picture of heterogeneity and variegation (Kompleksnost') of vegetative cover, which in the works of B. A. Keller and N. A. Dimi (1907) received the name "Kompleksnoy polupustyni," which was applicable to the vegetation of this (northern) part of the desert region. Moreover, within the limits of the spreading grassy-wormwood steppe deserts are concentrated the largest massifs of halophyte-meadow vegetation of "razlivy" and the biggest "limany," having been represented like alien dissemination in the midst of arid plains, and thus complicating the overall picture of Kompleksnost'.

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63. Grassy - wormwood steppe-deserts of Artemisia pauciflora and A. incana.

The grassy - wormwood steppe - deserts of Artemisia pauciflora and A. incana represent flat, slightly rolling plains by strongly pronounced micro-relief (mikrorel'ef), by specified variegation (Kompleksnost') of soil and vegetative cover. The predominant soils of heavy composition are clay and loamy, light chestnut, solonets in combination with meadow-chestnut western soils and different varieties of solonetz.

The most typical characteristic of vegetative cover in these conditions is a combination of classes of steppe varieties with desert associations which also creates a typical patchwork (Kompleksnost') picture.

The most widely distributed are the following principal members of the combination:

1) Typical - white wormwood (Artemisia incana and Festuca sulcata), zhitnyakov-white wormwood (A. incana and Agropyrum desertorum) and prutnyak-white wormwood (A. incana and Koeleria prostrata deserts in the light chestnut solonetz soils which cover the mikroplakorny flat areas. In all of these classes, the white wormwood (A. incana has the foremost significance. Other desert plants (A. pauciflora, Pyrethrum achilleifolium) are noteworthy in addition to a large group of steppe plants (Stipa Lessingiana, S. sareptana, Koeleria gracilis). The presence of a great number of ephemera and ephemerodae is very common in early spring. They cover pleshinka (Poa bulbosa vivipaia, Carex uralinsis, Tulipa biflora, Alyssum desertorum, Ceratocephalus orthoceras, Astrazalus testiculatus and several others) and there is also a sizable number of inferior sporphyte plants on the top surface of thesoil (Stratonostoc commune, Microcoleus vaginatus, Parmelia ryssolea, P. vagans, Bryum calspitosum and several others).

Associations of steppe-desert complexes (Kompleks) of the same appearance comprises from 40 to 60% of the area.

2) Black walnut (of Artemisia pauciflora), pyrethrum - blackwalnut (with Pyrethrum achilleifolium), camphor - blackwalnut (with Camphorosma monspeliacum), sedge - blackwalnut (with Agropyrum ramosum) deserts occur

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in columnar, cork - columnar and other varieties of solonets, in slightly raised elements of topography.

To these enumerated predominant plants are sometimes added biyurgun (Anabasis salsa) and prutnyak (Kochia prostrata). Some varieties of flower plants occur in individual associations - about 3 to 10, seldom amounting to 12 varieties.

The following are sometimes met in small quantities: viviparous meadow grass (Poa bulbosa vivipara) and a few efemera (Alyssum desertorum, Lepidium perfoliatum). More noteworthy are the fall annuals - Ceratocapus arenarius and Echinopsilon sedoides. Some interior types of vegetatation occupy an important position, especially Stratenostor commune, Parnolia vagans in addition to those mentioned above. These species components of the lower plants are the best.

These typical desert associations occur in 25 to 30 or 60% of complexes.

3) Fescue (tyrchak), tyrcovo-fescue (Festuca sulcata and Stipa capillata), feather-fescue (tipchak and Stipa Lessingiana), zhitnyakovo-fescue (tipchak and Agropyrum pectiniforme) steppes in meadow-chestnut soils covering the lowest places in micro-topography (mikrorel'ef) scutellum zapadin, lopatin).

Many steppe turf grasses add a typical steppe appearance to these associations in which they stand out sharply against a background of the rest of the plants in the complex.

In addition to these principal plants there are also met: koeleria (Koeleria gracilis), red feather grass (Stipa rubens), sedge (Agropyrum ramosum) and a large number of varieties of steppe grasses (principally "dry" grass) - Galatella villosa, Jurinea multiflora, Potentilla bifurca, Achillea nobilis, Galium verum, Phlomis tuberosa, Medicago falcata, Silene viscosa, Artemisia Austriaca and others. Grass cover here attains a full

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flowerage (Somknutost') and although both ephemera and lower plants are met here, their role is quite insignificant. In many zapadiny, especially in the northern areas, distinguished on the maps by contours, is met such steppe undergrowth as tavolozhka (Spiraea hypericifolia), marsh trefoil (Amygdalus nana) and Astragalus brachylobus.

Steppe zapadiny, on the average, cover 10 to 40% of the area in complexes, in proportion to their movement from north (where the percent of zapadiny is highest) to south where they undergo a gradual decrease in their role in the complexes, together with a poor quality species composition.

Such are the basic members of complexes which characterize this variety of grassy-wormwood steppe deserts.

The correlation of the basic members of a complex varies considerably, since the transitions between these classes (particularly in various variations of solonets) appear to be sufficiently well defined. The complex on the whole can be complicated by 4 or 5 members but ordinarily, it consists of two.

Two membered complexes are best typified by their well defined contour in the northern rayons of the Trans-Volga region, where are combined the tyrsovo-fescue steppes in the Zapadiny, with the black-wormwood deserts in the corky-columnar solonets, being approximately in equally relationship. But, in the northernmost steppe zapadiny, they sometime cover 60 to 70% of the area.

Four-membered complexes consist of the following associations: fescue-white wormwood (Artemisia incana and Festuca sulcata) in the Solonchak light chestnut soils; prutnyak-white wormwood (belaya polyn' and Kochia prostrata) in the deep columnar Solonetz; black wormwood and camphor-black wormwood (artemisia pauciflora and Camphorosma monspeliacum) in the corky and corky-columnar solonetz; and tyrsovo-fescue (Festuca sulcata and Stipa capillata) or tyrsikovo-fescue (tipchak and Stipa sareptana) in meadow chestnut soils

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of the zapadiny. Relationships between separate members of the complex are changed sharply, but in any event, these steppe associations occupy 10 to 30% of the area while the remaining area is covered with desert associations.

Throughout the entire area of the Pri-Caspian lowlands, very characteristic elements of the landscape are the peculiar suslik mounds, with a thin vegetative cover in which are included black wormwood (Artemisia pauciflora), white wormwood (A. incana), camphorosma (Camphorosma monspeliacum), prutnyak (Kochia prostrata), itsegek (Anabasis aphylla), annual solyank, a few types of ephemera and rare Komochky kny (Stratonostoc commune). Suslik mounds cover to to 1[illegible] of the area, thus complicating the picture since they lack a variegated complex cover.

The often met "limany" and raslivy," complicate the overall picture in the same way. They cause the emergence of an entire series of associations of a transitional order, from halophyte-meadow vegetation (and sometimes even meadow-boy) to desert associations.

Within the limits of contour 63p, the steppe zapadiny and the borders of limany (a large part of the area of limany are used for haying purposes.) are under cultivation.

The remaining territory is used as pasture land. The harvest of vegetative mass in the various elements of the complex differ sharply: from 1-2 to 14-16 centners per hectare and even from 20 to 2[illegible] centners per hectare. The average harvest of vegetative mass in the predominant steppe - deserts and desert associations amounts to 3-5 centner per hectare.

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63i. Grassy - wormwood steppe deserts of Artemisia incana

This variety of grassy-wormwood steppe deserts is spread over the lower watered plains from the poorly defined topography of the basin of the Kushum river (in the Grals), southward from lake Baskunchak and from the pyaten to the east and west of it. The predominant soils here are bown, light clayey and sandy.

In general outline, the vegetation is characterized by less clearly defined kompleksnost', by a noticeable reduction in the role played by fescue grass (Festuca sulcata); by the important role of white wormwood (Artemisia incana), by the almost complete absence of black wormwood (Artemisia pauciflora) together with the appearance of kokpek (Atriplex cana) and also by the sharp elimination of the number and sizes of zapadiny from the steppe associations.

Special contours westward and southward from lake Baskunchak are represented by the following complex:

1) Thilyukovo - white wormwood (Artemisia incana and Agropyrum desertorum) and very rare, fescue - white wormwood (A. incana and Festuca sulcata) deserts in brown desert-steppe, slightly solonetz oils. To these basic plants are added: pyrethrum (Pyrethrum achilleifolium), prutnyak (Kochia prostrata), meadow grass (Poa bulbosa vivipara), sedge (Agropyrum ramosum), feather grass (Stipa Lessingiana) grudnitsa (Galatella villosa) and several others.

The number of ephemera and lower plants in the soil is considerably less than is shown within the limits of contour 63p.

2) White-wormwood (Artemisia incana) and prutnyak (Kochia prostrata deserts in columnar and corky columnar solonetz.

In the capacity of associated plants, here, there are met the following: kokpek (Atriplex cana), camphorosma (Camphorosma monspeliacum)

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kzyl-kokpek (Statice suffruticosa), biyurgun (Anabasis salsa) and others. Meadow grass (Poa bulbosa vivipara) is quite common, as are a few fall annuals, as well as ephemera and kny (Stratenostoc commune).

3) Fescue (Festuca sulcata), tyrsikovo-fescue (tipchok and Stipa soreptana) and very scarce tyrsovo-fescue (tychak and Stipa capillata) steppes in poorly defined meadow chestnut soils of the smooth, flat zapading. In the composition of these steppe associating desert elements are more often admixed than steppe elements. Here are met: feather grass (Stipa Lessingiana), grudnitsa (Galatella glabrata), prutnyak (Kochia prostrata), pyrethrum (Pyrethum achilleifolium) meadow grass (Poa bulbosa vivipara) and others.

4) There are indeterminate combinations of white wormwood (Artemisia incana), prutnyak (Kochia prostrata), camphorosma (Camphorosma monspeliacum), black wormwood (Artemisia pauciflora) in the suslik mounds.

In the Uralo-Kushum watershed, complexes consist of the following members:

1) Fescue - white wormwood (Artemisia incana and Festuca sulcata) and Festuca sulcata) and fescue-pyrethrum-white wormwood (belaya molyn; Pyrethrum achilleifolium and tipchak) deserts in brown soils.

2) White wormwood (Artemisia incana), black wormwood-white wormwood (A. incana and A. pauciflora) and white wormwood-kokpek (Atriplex cana and Artemisia incana) deserts in different varieties of solonetz.

3) Tyrsikovo-fescue (Festuca sulcata and Stipa soreptana) and sedge-fescue (tipchak and Agropyrum ramosum) steppe associations in barely perceptible zapading with inferior meadow-chestnut solonetz soils.

4) Variegated combinations of Kokpek (Atriplex cana), camphorosma (Camphorosma monspeliacum), white and black wormwood (Artemisia incana and A. pauciflora) and biyurgun (Anabasis salsa) in suslik mounds.

The presence of halophyte vegetation is to the "pazlivy" and causes complication in the distribution of vegetation.

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The degree of farming used within the limits of contour 631 is considerably less than in the previously examined 63p.

Grassy wormwort associations are utilized here both as spring and fall pastures principally for horses, whose nourishment (vypas) is, for the most part, furnished by meadows in "rastivy."

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#64 Grassy-wormwood steppe deserts of sands and sandy loams in combination with wormwood (Artemsia ж incana s. l., A. arenaria) deserts and overgrown sands.

These deserts are spread over the right and left bank rayons of the lowermost course of the Volga and the neighboring rayons of the Pri-Caspain.

The topography is characterized by flat hills or by extremely hollow uvalisty, sometimes by small hillocks and flat lowlands, with separate berovskiy hills, which extend in a latitudinal direction and on which several areas are well defined.

The soils are sandy, sandy loam, clayey sand and brown. Between the berovskiy hills, there often are defined depressions with considerable solonetz and solonchak soils; flat solonchak depressions are also common in the valleys.

The presence of smooth and sometimes rough massifs of moving, loose or overgrown sands is characteristic of the entire territory. These sands originated as a result of chemical exploitation of sandy pastures in the middle of the last century.

Bit or little vegetative classes, which have a similar floral composition, have several differences since the length of the Volga is the boundary line for several eastern elements. So, these sandy massifs are met only or at least principally in the trans-Volga region: rang or ilak (sandy reed grass (Carex physodes) seldom appears); selin (Aristida pennata; Kulanguypyuk (Eremosparton aphyllum), several types of calligonum (Calligonum aphyllum and others of the section (sektsya) Pteroccus), and in the solonchak depressions, partidularly in the trans-Volga area, are met Kokpek (Atriplex cana) and biyurgun (Anabasis salsa).

From the standpoint of consolidation (zadernenіya) of the soil, vegetation is represented by meadow grass -- white wormwood (Artemisia incana and Poa bulbosa vivipara) and erkekavo-white wormwood (Artemisia incana and Agropyrum sibircum) deserts in compact sands in combination with white

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wormwood (Artemisia incana s. l., A astrachanica) and with sandy wormwood (Artemisia arenaria) in friable sands.

In the formation of designated associations, are met the following types, whose degree of participation can be distinguished adequately in individual associations: prutnyak (Kochia prostrata), milkwort (Euphorbia Sequieriana), ephedra (Ephedra vulgaris), brome grass (Bromus tectorum), and a number of other epemera, as for example, Eremopyrum triticeum, Alyssum desertorum Lepidium perfoliatum, Descurainia sophia, etc. Also quite characteristic and usually very abundant is ebelek (Ceratocarpus arenarius).

In the solonchak soils connected with the various depressions in topography, the following are predominant: solonyakovo-white wormwood and solonyak desert associations (Artemisia incana, A. ~~xxxxx~~ salina, Anabasis salsa, A. aphylla, A triplex cana, A. verrucifera), annual solonyaks and shvedki (Salsola and Suaeda) and also sarsarzan (Halocnemum strobilaceum), glasswort (Salicornia herbacea) and potash (Kalidium foliatum) in wet solonchak soils. Poorly formed ~~xxxxxxxxx~~ associations which have been trampled and stomped upon by cattle are being preserved in combination with kiyakovy (Elymus giganteus), mugwort (Artemisia scoparia) and ephemera-ebelok (Ceratocarpus arenarius and a few ephemera: Alyssum desertorum, Lepidium perfoliatum and others). On the left bank of the Trans-Volga area, Selin (Aristida pennata) associations also appear.

In this background, special pyaten of bare, shifting or semi-overgrown sands stand out together with special kurtina Elymus giganticus, Artemisia scoparia, Agriophyllum arenarium; in the Trans-Volga area, moreover, there are Aristida pennata and Eremosparton aphyllum.

In flat depressions of topography, included between the berovskiy mounds, the pyaten are characterized by solyank deserts (Halocnemum strobilaceum, Kalidium foliatum, Salicornia herbacea) and by associations of annual solyanks (Salsola nitraria, S. crassa, Suaeda confusa ~~x~~ and others). The presence of these desert ~~xxxxxxxx~~ halophytes is noted on the map by the mark "[illegible]" since the areas which they cover cannot be shown on a ~~xx~~ given scale.

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Groups of tamarisk (Tamarix laxa, T. Everamanni), saltpeter (Nitraria Schoberi), and teresken (Eurotia ceratoides) are met principally in the left bank area within the limits of a well-defined contour.

The agricultural significance of this vegetation is greatly utilized in the course of the entire vegetative period, as pasture land for cattle.

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65: Wormwood steppe-deserts of Artemisia incana and A. pauciflora, in a complex with solyank desert, fescue-feather grass and erekovy (in deserts) steppes

These deserts occupy the slightly rolling lowlands in the "lower steppes" of the right bank of the Volga, around lake Baskunchak, along the sides from Uzeno-Chizhinskiy razlivy, southward and eastward from Kamyak-Samarskiy lakes. The presence of broad uvaly in the southern areas is characterised on the map by contours, which depict the poorly defined, smoothed out berovskiy mounds. The soils are brown, light clayey, hard sandy loam, small massifs and fine pyaten of sandy soils. The latter cannot be shown on the scale of the map.

Vegetative cover within the limits of these contours is also complex, but the complexity is defined in poor structure. Here in the predominant background, covering 40 to 50% of the area, the fescue-zhitnyak - white wormwood - steppe-deserts have been disseminated by the small pyaten of other desert and steppe associations. In general, vegetation has a considerably more homogenous character than in previously mentioned varieties of "complex semi-desert" (63 p, 631).

The following associations are herewith represented in the composition of a complex:

1) Fescue-zhitnyak - white wormwood (Artemisia incana, Festuca sulcata and Agropyrum desertorum; the latter is represented by forms crossed with Agropyrum sibiricum) steppe deserts in brown, light clayey soils and zhitnyakovo-white wormwood (Artemisia incana and Agropyrum desertorum), and lastly erkekovo-white wormwood (Artemisia incana and Agropyrum sibiricum) steppe deserts in a very light (hard sandy loam and sandy) brown soils.

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The following types are significant in the composition of grassland (travostoy): Kochia prostrata, Galatella villosa, Artemisia austriaca, Poa bulbosa vivipara, Carex uralensis, Ephedra vulgaris, Koeleria gracilis, Phlomis pungens, Stipa Lessingiana and S. sareptana etc., The below-listed plants are quite common in the soils: Parmelia vagana and Stratonostoc commune. These and other associations cover most of the area and are outlined by huge massifs. They cover 40 to 50% of the total area of the contour.

2) Prutnyakovo-white wormwood (Artemisia incana and Kochia prostrata) and fescue-white wormwood (Artemisia incana and Festuca sulcata) in highly concentrated solonets soils and in deep columnar solonets soils. Here, in the composition of grassland are met the following: Poa bulbosa vivipara, Carex uralensis, Eragrostis minor and several others. Grassland is considerably more broken up than in the case in previously mentioned association and occupies 5 to 10% of the area.

3) Black wormwood (Artemisia pauciflora), white wormwood - black wormwood (Artemisia incanaand Kochia prostrata) deserts in the middle and corky solonetz. Here grassland is broken up and its species composition is poor: in addition to those just named, the following are also met: Poa bulbosa vivipara, Ceratocarpus arenarius, Alyssum desertorum, Lepidium perfoliatum, Camphorosma monspeliacum, Pyrethrum achilleifolium and others; an abundance of lower types of vegetation, such as: Stratonostoc commune, Parmelia vagans. They cover 20 to 30% of the area of the complex.

4) White wormwood-fescue (Festuca sulcata and Artemisia incana), typsovo-fescue (tipchak and Stipa capillata, S. sareptana) and fescue-zhitnyak (Agropyrum pectiniforme and Festuca sulcata) steppe associations in race, smooth zapoding with dark colored soils. The steppe appearance of these associations is considerably less accentuated than in the more northern rayons of the Pri-Caspian lowlands, at the expense of weakening the species compositions. In addition to the above-mentioned predominant plants, these may also be added: Koeleria gracilis, Agropyrum ramosum, A. desertorum, Phlomis pungens, Artemisia austriaca, Poa bulbosa vivipara,

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Carex uralensis and a few others. These associations occupy from 1 to 5% of this complex.

The principal agricultural utility is pasturing and haying. The harvest of the vegetative mass is 3.5 to 7.5 centners per hectare. The most valuable part (of the complex) is pryatnyak, which has a greater harvest (7 to 8 centners per hectare) and forage value. Fescue and zhitnyak are cut and used for hay; they yield 5 to 6 centners of good quality hay per hectare.

In this predominant background are met special pyaten of sandy loam and sandy soils (not shown on the map), which in their consolidated state are characterized by white wormwood-erkekov associations, and in their dispersed state are covered with overgrown kiyak (Elymus giganteus), kumarchik (Agriophyllum arenarium), mugwort (Artemisia scoparia) and other "pioneer" varieties.

Another characteristic feature is the presence of pyaten of solyank deserts, which have been conditioned to the lowland topography with brackish and solonchak soils. Here, there are met those which are common under similar conditions, namely: biyurgun (Anabasis salsa), kokpek (Atriplex cana; only on the left bank), suranov (Suaeda confusa), glasswort (Salicornia herbacea) and sarsazan (Halocnemum strobilaceum) deserts. The area which they occupy within the limits of contour 65, is not large and is therefore not noted on the map with an additional symbol.

A narrow strip of this contour extending along the left bank of the Volga (since this was surveyed by explorers in 1949) is characterized by the exceptional predominance of homogenous non-complex black wormwood deserts in Solonetz and highly concentrated solonets soils, which were almost brown. Viviparous meadow grass is often found here in the capacity of a companion of the black wormwood, particularly in the less concentrated solonets soils. In the more highly concentrated solonetz soils, it very common to find a considerable number of lichens (Parmelia, Aspicilia and others) amid the scattered bunches of black wormwood.

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698: Solyank deserts (usually in complex with wormwood deserts): of Anabasis salsa, Atriplex cana, Artemisia pauciflora, A. incana

The vegetation of the contours in figure 698 is represented by variegated complexes, in which the following associations participate:

1) Sarsazanniki (Halocnemum strobilaceum), suvanniki (Suaeda confusa), glasswort (Salicornia herbacea) and others in Solonchak soils. Regarding the composition of the above named, they are usually almost pure associations and also include the following: Petrosimonia brachiflora, Atriplex verruciferа and A. cana, and the annual types Salsola and Suaeda.

2) Black wormwood (Artemisia pauciflora) and white wormwood (Artemisia incana) and also camphoroma (Camphorosma Lessingii) and white wormwood or black wormwood camphoroma, biurgun (Anabasis salsa) and other associations in Solonets, early and middle columnar soils. Prutnyak (Kochia prostrata), itsegek (Anabasis aphylla), and alabuta (Atriplex tatarica) are often met in larger or smaller admixtures.

3) Shitnyak (Agropyrum desertorum) - white wormwood, tyrsikovo (Stipa sareptana) - white wormwood, shitnyak - prutnyak and other associations in the higher localities, particularly those with sandy loam soils and in the degraded deep columnar solonets soils. In their composition, the following are sometimes met in sizable mixtures: meadow grass (Poa bulbosa vivipara), mortuk (Bromopyrum triticeum), obelok (Cerato arpus arenarius), peppergrass (Lepidium perfoliatum and L. ruderale), burachak (Alyssum desertorum) and other annuals.

The representatives of countless groups of associations are met in very variegated relationships and numerous combinations. This number is especially increasing in instances of the proximity of vegetation of this type to meadow vegetation of "limany" or "razlivy," when a number of gradual crossings to meadow-solonchak and meadow vegetation are observed.

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As regards relationship with agriculture, the territories of a given contour have no value, since they are of poor quality being suited only as pastures for camels in late autumn and winter, when the Solyank is becoming more edible.

Members of these associations from the standpoint of grasses, are in such insignificant areas that it is not felt necessary to consider them.

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69. Solyank deserts and Solonchak devoid of vegetation

Large areas of barren Solonchak or desert-solyank types of vegetation are on the right bank of the lower course of the Ural river and the adjoining area of the Pri-Caspian lowlands. Further on are the large Solonchak Khaki to the northeast from lake Baskunchak along the boundary with the sandy massif Naryn; in the Kura-Arakaincksy lowlands and in portions of the Pri-Caspian adjoining it. The smooth pyaton of this type are met within the limits of the entire arid region, but they are especially typical of those areas included between the lower course of the Volga and Ural rivers. The presence of even smoother pyaton, which could not be shown on the scale of the map and noted by the symbol ψ, are very common in the sandy territory of the Pri-Caspian (contour 64), in the Sarpinskaya depression, and also along both sides of lake Bolshoy Manych. Furthermore, smooth masses of solonchak vegetation are noted along the shores of Sivash sea.

Even larger masses and smoother pyaton of solonchak vegetation have always been connected with flat depressions in topography, in more or less close proximity to ground water which is always quite salty. They are also water collecting areas in which salt waters lie stagnant throughout most of the summer.

Exceptionally sparse vegetation is represented almost exclusively by low, semi-bushwood and annual solonchaks, whose pyaton are interchanged with barren, so-called "wet" and "fluffy" (sukhliy) solonchaks, and in certain instance with takyr or takyroobraznly loam, which are devoid of vegetation.

As regards its agricultural significance, these are "abandoned" lands which are sometimes used as pastures for camels in the absence of more valuable pasture lands.

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69K: Solyank deserts and Solonchaks devoid of vegetation: Pri-Caspian variation (of Halocnemum strobilaceum, Atriplex Verrucifera, Kalidium foliatum, Halostachys caspica)

All of the largest areas of Solyank deserts belong to a given variation.

Here, there are characteristics of the association of sarsazan (Halocnemum strobilaceum), which cover uninterruptedly the entire surface of the lowland. The more depressed central portion of this area is covered with water or with solonchak mud.

The concentration of sarsazan is quite characteristic of the small, raised hillocks (bugorok), whose size depends on age and preservation of species. Sometimes, the middle of a flat section dies off and then the original krugoving are observed, whereupon, they are often torn off or form lopeshki with a poorly defined outline.

In such sarsazanniki, especially in the more "zlostniy" solonchaks, other plants are met more seldom and in decreasing numbers.

These include: halophytes, semi-undergrowth - potash (Kalidium foliatum), itsegek (Anabasis aphylla) and annual Solyanks, for example, ~~annual Solyanks, for example~~, glasswort (Salicornia herbacea), shvedki (Suaeda confusa and others), succulent (sochniy) solyanks (Salsola hitraria, S. crassa etc).

In conjunction with sarsazan associations, sometimes there are met, under conditions of less solinity and great moisture, suranov associations (Suaeda confusa), which as a rule are quite pure.

Others that are also quite devoid of association are the potashnika (Kalidium foliatum), and karabaraka (Halostachys caspica). Often groups of overgrown selitryanka (Nitraria Schoberi), which piles up in big mounds around the shrubs, whose height attains 1 to 1.5 meters. Such huge selitryanka, copped with thick shrubs and usually in the conical form of a hillock, afford a completely unique quality to the entire landscape.

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As regards the decrease in the number of solonchaks and the degradation of the margin of solonchak (vegetation), there are being introduced into the sarsazan: suranov, potashnik and other associations of a number of new types, such as: Atriplex cana, A. verrucifera, A. tatarica, Artemisia maritima salina, Frankenia hirsuta etc.

Near the solonchaks and in less "poorly" salted solonchak depressions are met: short shrubs of tamarisk (Tamarix laxa etc) and teresken (Eurotia ceratoides), along with the Selitryank (Nitraria Schoberi)

In the Kura-Arakseinskoy lowlands, this variation of solyank deserts is formed by several plants which are ecologically different one from another, as a consequence of which, they have been split up territorially. Here, two plants can be mentioned, which are dependent upon two formations of solyank deserts: Halostachys caspica and sarsazan (Halocnemum strobilaceum).

Halostachys caspica occupies the largest area in the central part of the Muganskiy steppe. Here, this semi-overgrown solyank grows in dry solonchak and highly saline soils with the occurrence of ground water up to 2.5 meters. With it in a complex is met Salsola crassa and Artemisia Meyeriana. Of the ephemera, these are common: Sphenopus divaricatus, Statice spicata, Hordeum geniculatum, Kremopyrum triticeum. A small mass covered with this vegetation, is also located near the village Shorsul in the Sal'yanskiy steppe.

Sarsazan (Halocnemum strobilaceum) is adopted to the wet and hilly solonchaks with its strongly saline upper crust of soil and occurrence of ground water up to 1 meter.

Mounds are formed around the separately growing shrubs of Sarsazan. The windward portion of these mounds is covered with semi-full branches of sarsazan. On the raised portions of these mounds are planted these ephemera Lepturus incurvatus, Sphenopus divaricatus, Hordeum geniculatum

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and sometimes even Bromus japonicus and B. rubens - plants of the more inspid soils. There is a distance between mounds which are devoid of vegetation, are wet and whose surface is covered with a thin salt crust.

Sometimes sarsazan grows in fine shoots, having been covered with alsmost pure brushwood. Sizeable areas of this type of vegetation are located in the southeast Shirvani, along the banks of the Caspian sea on the first sea terrace.

A large mass of sarsazanik is located on the former banks of the Araks river under the zero horizontal in the Muganskiy steppe (the so-called "solonchak Gadzhi-elchi"). Here, Atriplex verrucifera is added to sarsazan; also, in Mil'skiy steppe (Solonchak Shorgel'), in the Sal'yanskiy steppe (near the village of Khilla) along the course of the Kura river. Here, Solonchak surrounds the voloncanoes Kichuk-byul'-byul' and Duz-dag. Selitryanka (Nitraria Schoberi) grows in this Solonchar around the volcanoes. Mounds with Selitryanka vegetation attain a height of 2 to 3 meters. In the Kura-Araksinsk lowlands, the growth of Nitraria Schoberi is connected with the outlets of sub-surface salt water. As regards Anabasis aphylla, it is quite widely distributed in the smooth pyaton. It is met southeast of Shirvana and in Nakhichevan ASSR.

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Populus tremula (aspen kolki in forest-steppe)

Aspen kolki are seen principally in the Oka-Don valley where they are met quite often and also in the loess terraces of the Don east of Kharkov. They are also common in other regions of the forest-steppe.

Aspen kolki or "shrubs" (kustiy) in the forest-steppe are suited to the zapadiny with their solodized soils. Aspen kolki are usually met in a complex with pyaten of solonets, meadows and meadow-steppe zapadiny, solonchak and solonets meadows. Such combinations are very characteristic of the lowland-plains areas of the forest-steppe. Underbrush in the aspen kolki consist of friable buckthorn, Rosa cinnamomea, Salix cinera and others. Among the older aspen are met apple, pear, and bird-cherry trees, and at times, elm and oak trees. Sometimes the loess is absent. The following are predominant in the grass cover: Rubus caesius, meadow grasses and sedges (Calamagrostis epigeios, Digrahis arundinacea, Poa palustris, Carex riparia), and also several types of meadow and forest-meadow grass varieties (Filipendula Ulmaria, Lathyrus pratensis, Adonophora liliifolia and others). The aspen grove is usually encircled by a border of Salix cinera. In the center of the aspen grove, there is often a hilly marsh of Carex omskiana. Between the hillocks of this aspen grove there usually are Carex riparia, C. vesicaria, and on the hillocks there are Calamagrostis lanceolata. The inner border of the aspen grove, at the point of contact with the marsh, has produced Salix cinerea and S. rosmarinifolia.

In the saucer-shaped zapading, osier-beds of Salix cinera were first developed, then in these osierbeds, aspen appeared and began to grow. In the older aspen groves, at times, oak, which evidently attests to the change in the oak of the aspen grove.

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Quercus robur

Evidences of the cherry-oak (chereshchatiy dub) denote the smaller areas of the deep leafy-forests which have been preserved in the midst of cultivated lands of the broad-leaf forest belt and also denote the ostrovki of oak forest within the belt of forest meadows. Within the limits of the contour of meadow steppes, evidences of the cherry oak are displayed in the location of small forest massifs, which are preserved in the forest-steppe of the Russkaya lowland and which cannot be separated on the scale of our map in the form of special contours (distribution of cherry-oak in the European USSR has been shown in figure 5). A considerable number of evidences of oak have been located within the belt of variegated-fescue - feather grass steppes. These are the portions of deep-leafy-forests which, though small in area, must penetrate the network of the forest shelter belts of the afforested steppes of the European USSR.

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Solyank deserts in complex

Groups of semi-bushy (polukustarnichkoviy) Solyanks (Anabasis salsa, Atriplex cana - in the Pri-Caspian lowlands - Salsola dendroides, Haloc-nemum strobilaceum) are seen in the desert regions in the Pri-Caspian and Kura-Araksinskaya lowlands.

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